MODEL 3030PM
PORTABLE HEATED VOC ANALYSER
OPERATING MANUAL

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Part Number 3030PM/MAN

ADDENDUM TO 3030PM OPERATING MANUAL

Carbon Trap Maintenance

From 1994, analysers used in an environment with a high hydrocarbon ambient background, may be fitted with an additional carbon trap before the air purifier. The carbon granules must be changed after a period of one year to ensure efficiency. This period may need to be reduced if a very high background is encountered.

You will need a refresh pack of carbon granules. Part number CHEM/002.

1 Disconnect the analyser form the mains supply and disconnect all external plumbing.

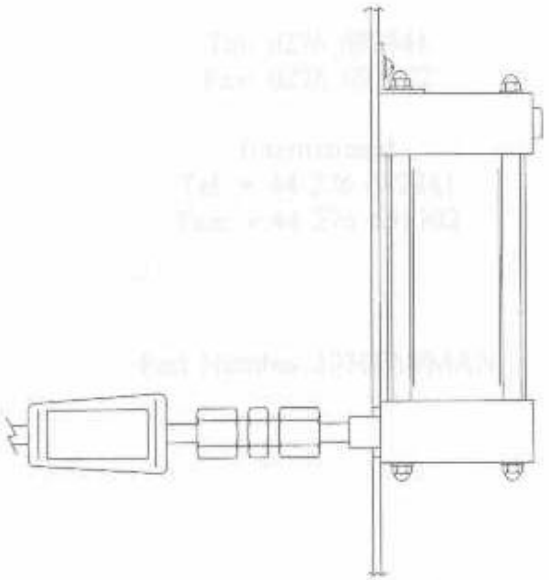
2 Remove the eight analyser cover screws and lift the cover clear.

3 Identify the in-line fitting connecting a blue filter to the carbon trap and, using one spanner on the fitting body and another on the nut, disconnect the fitting from the carbon trap.

4 Remove the screws securing the carbon trap to the rear panel and withdraw the trap.

5 Remove the domed nuts from one end of the assembly. Holding the assembly with the barrel vertical, remove the end cap. Discard the carbon granules. Remove, clean, and replace the two filters.

6 Add the contents of the refresh pack and re-assemble in the reverse order ensuring that the filters are correctly placed and that the 'O' rings are not damaged. Replacement 'O' rings are available under part number ORING/092



3030ADD1 Supply with manual if the carbon trap is fitted.

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1 INTRODUCTION

1.1 Analyser

1.1.1 The 3030PM is a heated portable hydrocarbon analyser designed to measure organic vapours in combustion stack gases and high dew point samples. The high temperature sample system has been specially developed to minimise sample loss or degradation.

1.1.2 A flame ionisation detector with a cylindrical collector, flame detector and igniter, and housed in a temperature controlled oven, produces an electrical signal proportional to the number of carbon atoms present in the sample. This is amplified and digitised for maximum accuracy. Automatic fuel enrichment ensures easy and reliable ignition while a built-in catalyst transforms ambient air into hydrocarbon-free air for use as Zero gas, burner air, and make-up air for the sample system.

1.1.3 The full function embedded microprocessor provides both digital and analogue interfaces for data acquisition. Additional features allow automatic ignition, calibration and ranging. An RS232 serial link using 'AK' protocol allows communication with Signal's dedicated Host controller or with a PC running special software giving full remote control. Remote control of major functions is also possible using parallel logic or switches to set the state of digital control lines. Remote indication of analyser status is also provided.

1.1.4 An optional cutter allows simultaneous total, methane, and methane-free hydrocarbon measurement.

1.1.5 Miniature bottles of fuel and span gas are held below the analyser in a combined bottle rack and analyser stand. Full size bottles can be used for continuous monitoring.

1.1.6 This manual does not apply to the Model 3030P analyser. The 3030PM analyser contains many enhancements over the 3030P and the differences are sufficient to cause confusion if the wrong manual is used. Check the model number at the bottom right of the front panel.

1.2 Keys, Indicators, and Warnings

1.2.1 This manual makes use of the square brackets "[]" to show where a key press is required. As an example, the key to select Sample measurement would be shown as [SAMPLE]. It also makes use of the brace (or curly) brackets to indicate a warning number. As an example, a flame-out warning would be shown by {E1}. Flashing indicators are cautionary signals to show functions which are not ready or that have encountered their limit conditions.

1.2.2 If you do not have an analyser in front of you while reading this manual, refer to the fold out diagrams on pages 53, 54 and 55 for the basic controls and connections.

1.3 Getting Started

1.3.1 Unless you are familiar with the installation of gas analysers, we recommend that you read Section 3 up to, and including, section 3.4. Install the analyser to include all the facilities that you require.

1.3.2 Read all of section 4 and follow the instructions. This will take you through a step by step sequence to allow the measurement of the VOC concentration in your sample gas.

2 SPECIFICATION

2.1 Safety

2.1.1 The instrument has been constructed in accordance with prescribed safety standards. All hazardous circuits are shielded within the instrument. The detector and fuel lines are in ventilated areas. A flame sensor overrides the fuel supply turning it off when no flame is present.

2.2 Power

2.2.1 Analyser

2.2.1.1 Switchable between 115 Vac and 230 Vac ñ15%, 50 Hz or 60 Hz.

2.2.1.2 Maximum power consumption 400 W.

2.2.1.3 Fuse rating 5 A (115 Vac) or 3.15 A (230 Vac). Fuse type 'T' (HBC).

2.2.1.4 Fused IEC 320 plug on rear panel accepts IEC320 sockets.

2.2.2 Heated line and Controller

2.2.2.1 Fixed 115 Vac or 230 Vac ñ15%, 50 Hz or 60 Hz.

2.2.2.2 Maximum power consumption 600 W for a 5 m line and 1200 W for a 10 m line. Approximately 10 W + 120 W/m for other line lengths.

2.2.2.3 Fuse rating: (115 Vac) 16 A for both 5 m and 10 m lines.
(230 Vac) 10 A for 5 m and 16 A for 10 m lines.
Fuse type 'T' (HBC).

2.3 Pneumatics

2.3.1 Fuel and calibration gas connections use ¼" (6.35 mm) tube and self sealing quick-connects. Sample gas connections use ¼" (6.35 mm) tube and fittings.

2.3.2 Fuel

2.3.2.1 Required fuel is a 40% Hydrogen 60% Helium mixture. The analyser can be adapted at the factory to use pure Hydrogen. This requires changes to the fuel and sample flow-rates.

2.3.2.2 Miniature regulated fuel bottle with one litre capacity. An alternative fuel source can be used. It must provide an input pressure from 25 psi to 35 psi (1.7 bar, 170 kPa to 2.4 bar, 240 kPa) and a flow of 180 ml/min (40% H2, 60% He) or 60 ml/min (H2).

2.3.3 Air

2.3.3.1 An internal pump and catalytic air purifier provides 600 ml/min hydrocarbon-free detector air, and sufficient zero calibration gas from local ambient air. Local air must have less than 500 ppm Methane equivalent hydrocarbon content to be usable.

2.3.3.2 An AIR INLET port on the rear panel allows bottled air to be used. The inlet pressure should be raised by 0.5 psi (35 mbar, 3.5 kPa) above ambient for each 10 m length of piping. **DO NOT EXCEED 10 psi (690 mbar, 69 kPa) pressure measured at the inlet port.**

2.3.4 Span Calibration Gas

2.3.4.1 Miniature regulated calibration gas bottle with one litre capacity. Calibration gas concentration is 500 ppm Methane in Air. An alternative calibration gas source (with a different concentration to suit the application) can be used. It must provide an input pressure from 25 psi to 35 psi (1.7 bar, 170 kPa to 2.4 bar, 240 kPa) and a flow of 1.5 l/min.

2.3.5 Sample

2.3.5.1 Inlet via ¼" (6.35 mm) tube fitting.

2.3.5.2 0.4 micron (0.4 µm) internal filter. Element replacement from the rear.

2.4 Ranges

2.4.1 Eight ranges, 0-4 ppm, 0-10 ppm, 0-40 ppm, 0-100 ppm, 0-400 ppm, 0-1000 ppm, 0-4000 ppm and 0-10000 ppm with manual and auto-range selection. Auto-range status indicated on the front panel.

2.5 Display

2.5.1 Large four digit LED display for concentration, and eight character alphanumeric for units and gas. Horizontal bar graph shows fraction of chart recorder range.

2.6 Detector

2.6.1 Flame Ionisation Detector with cylindrical collector complete with flame-out detector and igniter mounted on heated sample manifold block. Automatic or push button ignition with fuel enrichment.

2.7 Oven Temperature

2.7.1 Nominally 190°C. Adjustable between 130°C and 210°C. Stability ± 4°C. Warning given if outside set point ± 15°C. Measurement resolution 1°C.

2.8 Catalyst Temperature

2.8.1 Nominally 600°C. Adjustable between 0°C and 640°C. Stability ± 10°C. Warning given if outside set point ± 60 °C. Measurement resolution 4 °C.

2.9 Catalyst Efficiency

2.9.1 Greater than 98% removal of Methane (500 ppm maximum concentration).

2.10 Warm-up Time

2.10.1 30 min.

2.11 Repeatability

2.11.1 Better than ñ1% of range full scale.

2.12 Response

2.12.1 Less than 2 s to reach 95% of value.

2.13 Bypass Flow Sensitivity

2.13.1 Less than 4% of reading when the flow varies from 1 l/min to 3 l/min.

2.14 Zero Drift

2.14.1 Less than 1% of range, or 1 ppm in eight hours, whichever is the greater.

2.15 Ambient Temperature Effect

2.15.1 An ambient temperature change from 10 °C to 30 °C has an effect on the reading of less than ±1% of range full scale.

2.16 Detector Noise

2.16.1 Less than 0.1 ppm Methane equivalent measured over a period of 1 min.

2.17 Linearity

2.17.1 Better than 0.5% of range full scale.

2.18 Carbon Number Correlation

2.18.1 Less than 5% difference in carbon number correlation between Toluene, Hexane, Propylene and Propane when using Hydrogen/Helium fuel.

2.19 Oxygen Synergism

2.19.1 500 ppm Methane in Air changed to 500 ppm Methane in Nitrogen has less than 0.5% effect when using Hydrogen/Helium fuel.

2.20 Methane Cutter (optional)

2.20.1 85% efficiency in Propane/Methane separation.

2.20.2 When set to NON mode, the dwell time is a nominal 30 s in each path.

2.20.3 The cutter can be poisoned by heavy metals such as lead, and some silicone compounds. Do not use this option where these contaminants are present.

2.21 Analogue Outputs

2.21.1 Simultaneous voltage and isolated current outputs. The non-methane option includes an additional two pairs of outputs so that all three measurements can be recorded.

2.21.2 Concentration Output. 0-10 V represents selected range span.

2.21.2.1 Over range capability ±15%. (-1.5 V to 11.5 V).

2.21.2.2 Lowest load resistor 2 kÙ

2.21.2.3 Continuous short circuit allowed. Recovery < 15 min.

2.21.3 Concentration Output. 4-20 mA represents selected range span.

2.21.3.1 Over range capability ±15%. (1.6 mA to 22.4 mA).

2.21.3.2 Highest loop resistance 600 ê including cable and any current sense resistance.

2.21.4 Range Output. 0-8 V represents selected range number.

2.21.4.1 Ranges are numbered from 1 (most sensitive) to 8 (least sensitive) and the output changes by approximately 1 V for each range step. Loss of mains power is indicated by an output of 0 V.

2.21.4.2 Lowest load resistor 2 kÙ.

2.21.4.3 Continuous short circuit allowed. Recovery < 15 min.

2.22 Fault Relay

2.22.1 Contact ratings are 1 A at 50 Vdc.

2.22.2 Isolation > 10 MÙ at 50 Vdc.

2.23 Digital Inputs

2.23.1 Digital control lines are provided for the remote control of Range, Input Port, Measurement Mode, Sleep (Standby), and Calibration. The inputs are arranged for contact closure to common return to represent the TRUE condition. This is sometimes referred to as "Negative Logic". All voltage levels are with respect to the common return line.

2.23.2 Absolute maximum input +5.0 Vdc.

2.23.3 Absolute minimum input 0.0 Vdc.

2.23.4 Logic 1 (TRUE) level < 1.2 Vdc.

2.23.5 Logic 0 (FALSE) level > 3.7 Vdc.

2.24 Digital Outputs

2.24.1 Digital output lines are provided for the remote indication of the analyser status. Range, Input Port, Measurement Mode, Calibration in Progress, Calibration Failed, High Alarm, and Low Alarm are available.

2.24.2 Voltages must not be applied to these outputs. Continuous short circuit to common return is allowed.

2.24.3 Logic 1 (TRUE) level < 1 Vdc at 5 mA sink to common return.

2.24.4 Logic 0 (FALSE) level from a nominal 5 Vdc via 1 kê resistor.

2.25 Serial Interface

2.25.1 RS232C serial interface using 'AK' protocol provides full remote control and reporting facilities.

2.25.2 Factory set to 9600 baud, no parity, 8 data bits, 1 stop bit, XON / XOFF enabled.

THE ANALYSER AND HEATED LINE CONTROLLER MUST NOT BE USED WITHOUT A SAFETY EARTH CONNECTION

Heated line, sample inlet, exhaust and bypass connections

WILL BE HOT

While the analyser or heated line controller are ON, and for some time afterwards

TAKE PRECAUTIONS AGAINST BURNS BY USING GLOVES

3 INSTALLATION

3.1 Introduction

3.1.1 Installation requires the use of a tool set compatible with electrical and pneumatic skills. A suitable set of tools for a minimum installation consists of an electrician's flat bladed screwdriver for the mains connections, a sharp knife for cutting PTFE tubing, and a 9/16" (14.3mm) A/F spanner. Full installation of remote control, chart recorder, and other features will require the use of a soldering iron plus solder, wire cutters, wire strippers, small pliers, and a working knowledge of the equipment to be connected. Plumbing in stainless steel will require the use of pipe cutters and benders. We, or our local agent, can offer an installation service if you do not have the necessary skills.

3.1.2 All functions provided by the front panel buttons can be mimicked by commands sent via the RS232 serial port. A number of additional commands not present on the front panel are available via this port. Connect the serial port to one of the ports on the host computer, or to the serial port of any PC having either 'Signal' or 'Custom' software to affect control. For those wishing to write their own software, section 8 defines the communication protocol and lists the commands available together with their parameters and responses. This is the preferred method of data-logging where a PC based system is available. The RS232 port may require customisation if the factory default settings are not satisfactory.

3.1.3 Connections to analogue data-logging equipment or chart recorders are available on the CHART connector. Voltage and isolated current outputs are available. Consult section 2 for load restrictions.

3.1.4 The pneumatic and electrical connectors are found on the front and rear panels. If you do not have an analyser in front of you while reading this manual, refer to the fold out diagrams on pages 53 and 54.

3.2 Location

3.2.1 The analyser and heated line controller should be placed in a dry and sheltered location out of direct sunlight, avoiding drafts, and protected from rain. All mains power connections must be protected from water ingress.

3.3 Mains Power Connection

3.3.1 The analyser is supplied with a 2 m long mains lead with an IEC320 socket at one end for connection to the analyser. The other end should be connected to a mains plug to suit the local supply.

3.3.1.1 Check the local mains voltage and set the Voltage Selector switch on the rear panel to 115 V or 230 V according to the supply.

3.3.2 The 540 heated line controller is factory set to suit the mains voltage requested on the order. It comes with an attached mains lead. The free end should be connected to a mains plug to suit the local supply.

3.3.3 Standard Wiring

3.3.3.1 Connect the BROWN wire to the LIVE (L) pin.

3.3.3.2 Connect the BLUE wire to the NEUTRAL (N) pin.

3.3.3.3 Connect the GREEN & YELLOW wire the EARTH (E) pin.

3.3.4 Portable Safety Isolating Transformer Supplies

3.3.4.1 Connect the BROWN wire to one output.

3.3.4.2 Connect the BLUE wire to the other output.

3.3.4.3 Connect the GREEN & YELLOW wire to the transformer earth. The earth must be continuous back to the mains supply, or a local earth must be provided.

3.3.4.4 Transformers with an earthed centre tap can be used. Connect the GREEN & YELLOW wire to the centre tap or earth point.

3.4 Gas Connections

3.4.1 The analyser is a very sensitive detector of hydrocarbons. It is very important not to connect contaminated tubing to the instrument. Contaminated tubing can be cleaned by heating in an oven at 200 °C for at least two hours while passing clean air through the tube.

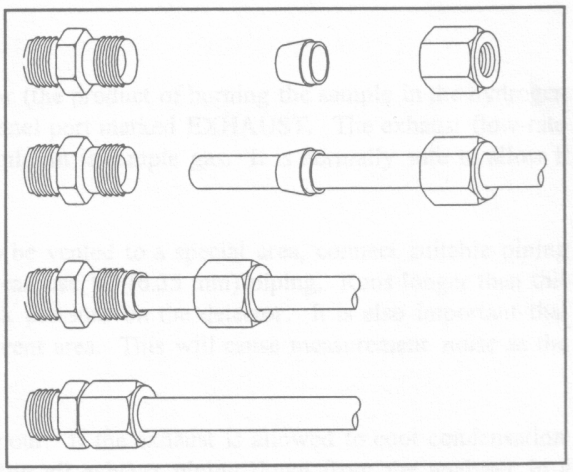


Figure 1 Pipe Fitting Assembly

3.4.2 ¼”(6.35 mm) O.D. tube is required for all connections; 0.060" (1.5 mm) wall PTFE tube is recommended. Slide the nut and ferrule over the tube. The tubing should be inserted into the tube fitting aperture and held firmly against the end stop. The nut should be rotated clockwise until it is "finger tight". Tighten the nut a further 1¬ turns with a 9/16" (14.3 mm) A/F spanner. When connections are remade, it is only necessary to tighten the nut slightly with the spanner after making it "finger tight".

3.4.3 Fuel

3.4.3.1 Place the fuel cylinder in the right hand section under the analyser. Connect the hose to the front panel quick-connect fitting marked FUEL. The front panel and hose connectors for the fuel line are colour coded with a YELLOW band.

3.4.3.2 If using the miniature cylinder supplied with the analyser, open the valve one turn. It is not necessary to open the valve further. If using an alternative supply, it must be pressure regulated to 30 psig (2.1 bar, 210 kPa).

3.4.4 Air

3.4.4.1 Unless an external air supply is connected the analyser will use local ambient air, removing hydrocarbons by a catalytic process. If the local air has high hydrocarbon content, the catalyst will not be able to remove all traces and an elevated zero will result. Refer to section 2.3.3 for ambient air limits.

3.4.4.2 An external air supply can be connected to the AIR INLET port. Do not connect an industrial shop air supply as this normally has a high oil content and may result in serious contamination of the instrument. Only connect to a known oil-free air supply.

3.4.5 Span Calibration Gas

3.4.5.1 Place the span calibration cylinder in the left hand section under the analyser. Connect the hose to the front panel quick-connect fitting marked SPAN. The front panel and hose connectors for the span line are colour coded with a BLACK band.

3.4.5.2 If using the miniature cylinder supplied with the analyser, open the valve one turn. It is not necessary to open the valve further. If using an alternative supply, it must be pressure regulated to 30 psig (2.1 bar, 210 kPa).

3.4.6 Sample

3.4.6.1 The sample gas is transported from the sample point via a heated line to the analyser. This ensures that hydrocarbon sample is not lost by condensation. Connect one end of the heated line to the sintered filter (accessory kit), and the other end to the rear panel port marked SAMPLE. If the analyser or heated line are switched on, this port and the heated line pipe ends WILL BE HOT. Wear heat-resistant gloves if necessary. The filtered end of the line should be inserted into the sample point.

3.4.7 Exhaust

3.4.7.1 The combustion gas leaving the detector (the product of burning the sample in the hydrogen flame) leaves the analyser at the rear panel port marked EXHAUST. The exhaust flow-rate is less than 1 l/min of which about 8 ml/min is sample gas. It is normally safe to allow it to vent to atmosphere.

3.4.7.2 If local safety standards require this to be vented to a special area, connect suitable piping to the port. Short runs (less than 2 m) can use 1/4" (6.35 mm) piping. Runs longer than this must be in larger piping to reduce back pressure on the detector. It is also important that there are no pressure variations in the vent area. This will cause measurement noise as the pressure variations affect gas flows.

3.4.7.3 The exhaust gas will contain water vapour. If the exhaust is allowed to cool condensation will form and may block the pipe. Run all exhaust piping down from the analyser in a smooth and continuous drop. The vent area must be able to remove the water as it exits the pipe.

3.4.7.4 Condensation may be corrosive. Pipes and fittings should be corrosion resistant. Stainless steel for fittings and PTFE for pipes are recommended.

3.4.8 Hot Bypass

3.4.8.1 Unused sample gas and make-up air leave the analyser at the rear panel port marked HOT BYPASS. If the analyser is switched on, this port WILL BE HOT. Wear heat resistant loves if necessary.

3.4.8.2 If local safety standards require this to be vented to a special area, connect suitable piping to the port. Short runs (less than 2 m) can use 1/4" (6.35 mm) piping. Runs longer than this must be in larger piping to reduce back pressure. It is also important that there are no pressure variations in the vent area. This will cause measurement noise as the pressure variations affect gas flows.

3.4.8.3 The bypass gas may contain water vapour. If the bypass is allowed to cool, condensation will form and may block the pipe. Run all bypass piping down from the analyser in a smooth and continuous drop. The vent area must be able to remove the water as it exits the pipe.

3.4.8.4 Condensation may be corrosive. Pipes and fittings should be corrosion resistant. Stainless steel for fittings and PTFE for pipes are recommend

3.5 Chart Connections

3.5.1 Identify the 15 way 'D' plug and housing in the accessory kit. It connects to the 15 way socket marked CHART on the front panel.

3.5.2 Chart connector pin allocation is given in Figure 2.

3.5.3 A typical installation may use the TOTAL voltage output and the RANGE VOLTAGE output wired directly to an adjacent chart recorder, or the TOTAL current output wired to a remote data logger. Voltage and current outputs are available at the same time.

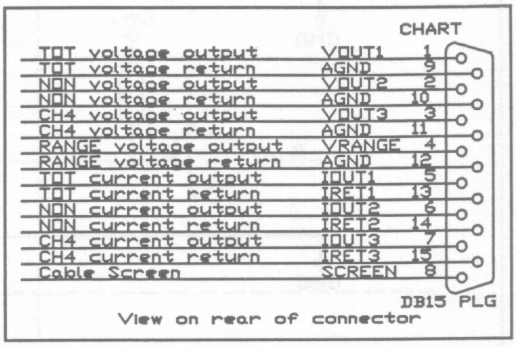


CHART
TOT voltage output VOUT1 1
TOT voltage return AGND 9
NON voltage output VOUT2 2
NON voltage return AGND 10
CH4 voltage output VOUT3 3
CH4 voltage return AGND 11
RANGE voltage output VRANGE 4
RANGE voltage return AGND 12
TOT current output IOUT1 5
TOT current return IRET1 13
NON current output IOUT2 6
NON current return IRET2 14
CH4 current output IOUT3 7
CH4 current return IRET3 15
Cable Screen SCREEN 8
DB15 PLG
View on rear of connector
Figure 2 Chart Connections

3.5.4 The RANGE voltage output can be used over long distances. Any voltage drop down the line just offsets the trace slightly. Range indication does not require great accuracy.

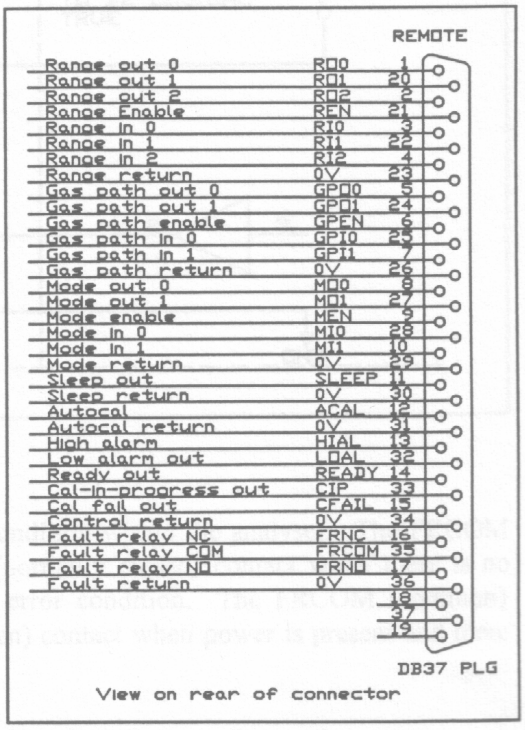
3.5.5 Analysers fitted with the Non-Methane option will have additional CH4 and NON outputs available.

3.6 Remote Connections

3.6.1 Identify the 37 way 'D' plug and housing in the accessory kit. It connects to the 37 way socket marked REMOTE on the front panel.

3.6.2 Remote connector pin allocation is given in Figure 3.

3.6.3 Typical connections for switch, logic, and isolated logic are given in Figure 3. The grounded switch method of control is useful where the analyser must be placed in a different area from the control and where only manual control is required. Computer or process controllers should use the direct or isolated method of operation. Isolated connections should be used if the analyser is in an electrically noisy environment, with the analyser some distance from the controlling logic, and where the controlling logic is connected to the local earth.


REMOTE
Range out 0 RO0 1
Range out 1 RO1 20
Range out 2 RO2 2
Range Enable REN 21
Range In 0 RI0 3
Range In 1 RI1 22
Range In 2 RI2 4
Range return 0V 23
Gas path out 0 GPO0 5
Gas path out 1 GPO1 24
Gas path enable GPEN 6
Gas path In 0 GPI0 25
Gas path In 1 GPI1 7
Gas path return 0V 26
Mode out 0 MO0 8
Mode out 1 MO1 27
Mode enable MEN 9
Mode In 0 MI0 28
Mode In 1 MI1 10
Mode return 0V 29
Sleep out SLEEP 11
Sleep return 0V 30
Autocal ACAL 12
Autocal return 0V 31
High alarm HIAL 13
Low alarm out LOAL 32
Ready out READY 14
Cal-in-progress out CIP 33
Cal fail out CFAIL 15
Control return 0V 34
Fault relay NC FRNC 16
Fault relay COM FRCOM 35
Fault relay NO FRNO 17
Fault return 0V 36
18
37
19
DB37 PLG
View on rear of connector
Figure 3 Remote Connections

3.6.4 Some typical installation arrangements are shown in Figure 4.

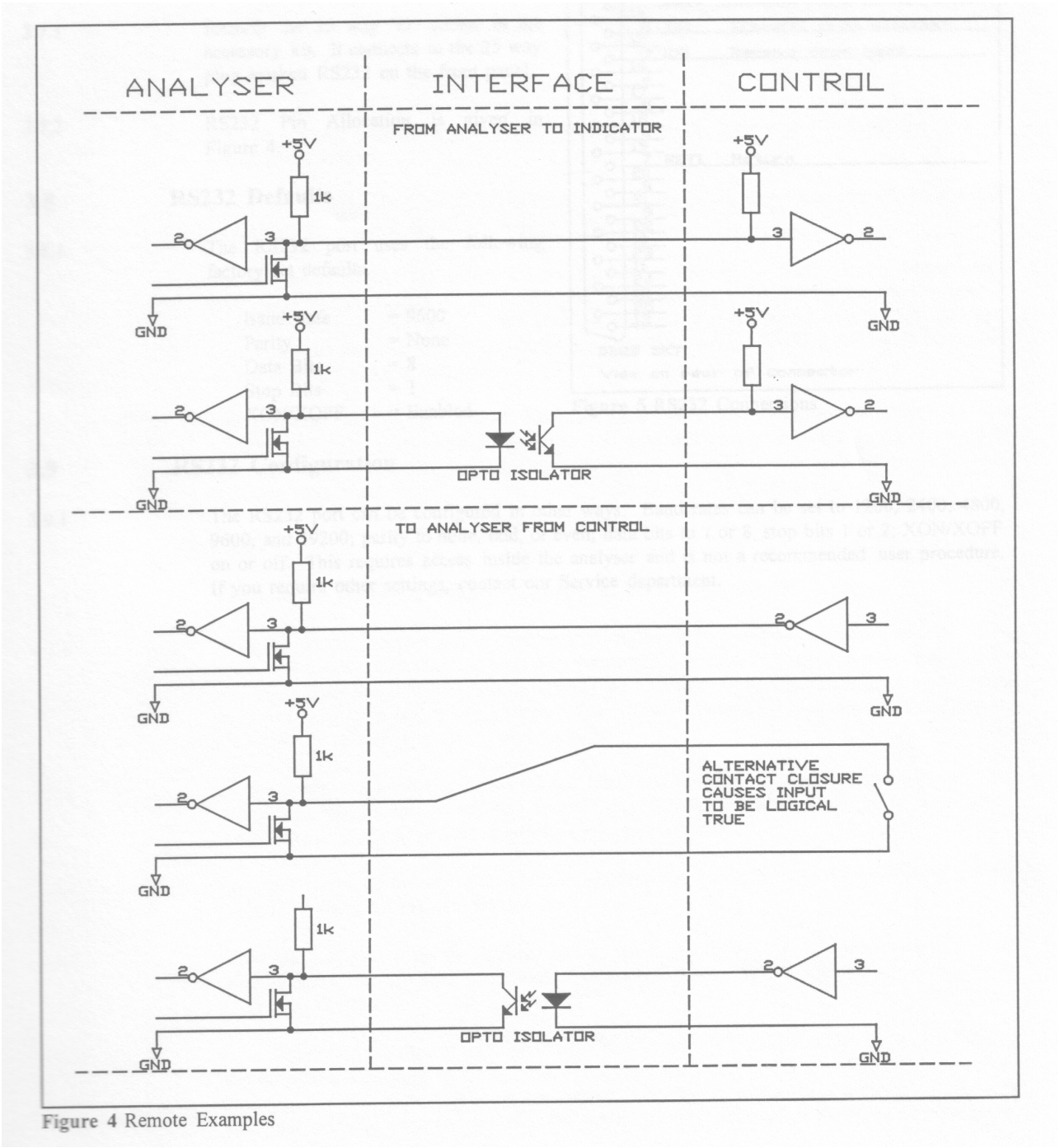


Figure 4 Remote Examples

3.6.5 Relay contacts are available for warning of a fault condition within the analyser. The FRCOM (common) contact will be connected to the FRNC (normally closed) contact when there is no power to the analyser and when there is a fault or error condition. The FRCOM (common) contact will be connected to the FRNO (normally open) contact when power is present and there is no fault or error condition detected.

3.7 RS232 Socket Connections

3.7.1 Identify the 25 way 'D' socket in the accessory kit. It connects to the 25 way plug marked RS232 on the front panel.

3.7.2 RS232 Pin Allocation is given in Figure 4.

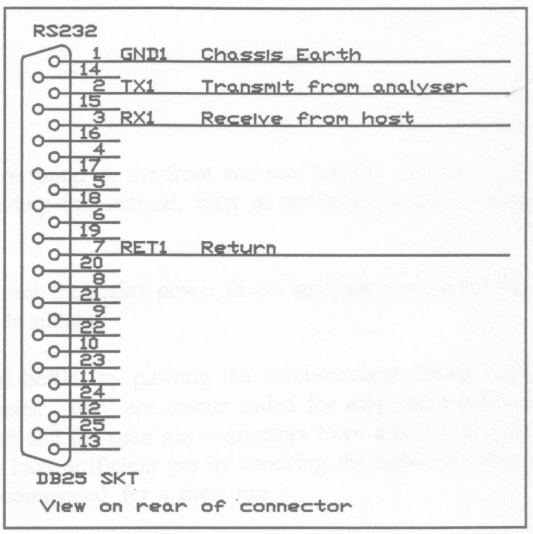


Figure 5 RS232 Connections

3.8 RS232 Defaults

3.8.1 The RS232 port uses the following factory set defaults.

Baud Rate	= 9600
Parity	= None
Data Bits	= 8
Stop Bits	= 1
XON / XOFF	= Enabled

3.9 RS232 Configuration

3.9.1 The RS232 port can be configured in other ways. Baud rates can be set to 1200, 2400, 4800, 9600, and 19200; parity to none, odd, or even; data bits to 7 or 8; stop bits 1 or 2; XON/XOFF on or off. This requires access inside the analyser and is not a recommended user procedure. If you require other settings, contact our Service department.

4 BASIC OPERATION

4.1 Installation

4.1.1 The pneumatic and electrical connectors are found on the front and rear panels. If you do not have an analyser in front of you while reading this manual, refer to the fold out diagrams on pages 53, 54 and 55.

4.1.2 Follow the instructions in section 3 to connect the mains power to the analyser and heated line controller. Ensure that the mains voltage is suitable.

4.1.3 Connect the small fuel and calibration gas bottles by pushing the quick-connect fittings onto their respective inlet ports on the front panel. They are colour coded for easy identification. The fuel connectors have a YELLOW band and the span gas connectors have a BLACK band. Ensure that the fuel and calibration bottles have sufficient gas by checking the bottle pressures. At least 200 psi (14 bar, 1400 kPa) is recommended for a short run.

4.1.4 Connect one end of the heated line (the end with the electrical connector) to the SAMPLE/FILTER inlet. Attach the heated line electrical connector to the output on the 540 controller. The heated line should be laid out straight or in a gentle curve. Do not coil the line. This will cause local overheating and possibly damage the PTFE inner tubing.

4.2 Operation

4.2.1 Switch on the analyser ([ON/OFF] key) and the heated line controller.

4.2.2 At switch on, the analyser display will show all segments lit for a period of three seconds. This allows the display to be checked each time the power is applied. The top left numerical display will then show the software number (Pnnn) for a period of two seconds, and the software revision (rnnn) for a further two seconds. You will need to quote these numbers if you require help with the operation or set-up of the analyser.

4.2.3 Set the heated line controller to 180 øC and leave both the analyser and line to warm up. This will take about 20 min. During this time the display will frequently show {E1}. This means that the flame is not lit and the analyser is not ready for use.

4.2.4 Open the valves on the fuel and calibration bottles one turn. There is no need to open them further. Opening further can damage the valves.

4.2.5 Select [ZERO] gas. Press the [PUMP] button, check that the PUMP light turns on and that the pressure gauge on the front panel registers between 5.5 psi to 7.5 psi (380 mbar, 38 kPa to 520 mbar, 52 kPa).

4.2.6 Press and hold the button marked [IGN] for four seconds. This will ignite the detector flame and cause the IGN light to flash. Allow a further ten minutes for the flame temperature to stabilise. The IGN light will be on continuously once the flame has been detected. If the IGN light goes out after about five minutes, the flame either did not light or could not be maintained.

4.2.6.1 If this is the first time the analyser has been switched on since it was plumbed up, it is possible that there is air in the fuel lines. Repeat the ignition procedure up to five times to ensure that the fuel path is purged of air.

4.2.7 Insert the sample probe into your sample point. Select [SAMPLE].

4.2.7.1 If the oven is not at temperature, sample will not be selected. The SAMPLE light will flash showing that SAMPLE gas is required, but ZERO gas will remain selected. Wait until SAMPLE is automatically selected when the oven reaches its working temperature.

4.2.8 Press [RANGE], then [UP] repeatedly until the display shows 'Auto'. Wait for the display to change back to concentration. You are now able to read hydrocarbon concentration directly from the display in Carbon Number (Methane) equivalence.

4.2.9 If you have the Non-Methane option, select [TOT] for total hydrocarbon, [CH4] for methane, or [NON] for non-methane measurement.

4.2.10 Unless the analyser was recently calibrated, the concentration value may not be as accurate as you require. Press [SET][CAL]. Check that the displayed value agrees with the span calibration certificate. If the value is the same, press [SAMPLE] to return to measurement mode. If not, press [UP] or [DOWN] to change the displayed value, then press [SET] as confirmation. There is a faster way of changing the value if the required value is very different from the required one. Refer to section 6.4 for full instructions.

4.2.11 After checking the calibration value, press [CAL]. Calibration always occurs using the TOT mode. A full zero and span calibration will occur. During this time the CAL light will glow, and the ZERO and SPAN lights will glow as each type of calibration is performed. If the CAL light flashes at the end of the calibration procedure, a fault in calibration was encountered and corrective action is required.

4.2.11.1 If a zero calibration failure occurred, check that catalyst temperature has reached its working temperature by pressing [TEMP]. If the top right display shows "C OV" press [TEMP] again until "C CA" is displayed. Check that the analyser is not located where a high hydrocarbon background is present. The analyser can remove up to 500 ppm Methane equivalent from the ambient air but higher concentrations will cause a zero offset. Use bottled air connected to the air inlet port if necessary.

4.2.11.2 If a span failure occurred, check that the SPAN cylinder valve has been opened and that the calibration certificate value agrees with the [SET][CAL] value.

4.2.12 Refer to section 5 for full instructions on calibration, chart recorder outputs, alarms, auto-ignition, and all the other features.

4.3 Decommissioning

4.3.1 Remove the sample probe from the sample point and allow it to sample clean air until the reading drops to near zero. This ensures that no organic hydrocarbons are present in the sample paths which may otherwise condense as the analyser

4.3.2 Switch the heated line controller off. Allow cool air to purge through the line for about thirty minutes to reduce the line temperature. Do not tightly coil the heated line until it is cool (about 60°C to 70°C). Coiling when hot may cause the PTFE inner tubing to kink causing restricted flow next time it is used. If the line must be disconnected before it is cool, take care to avoid skin contact with the fittings (wear heat resistant gloves if necessary) and only lightly coil it for transportation.

4.3.3 Disconnect the heated line from the controller and analyser. The SAMPLE / FILTER fittings will still be hot. Avoid skin contact.

4.3.4 Turn the pump off and close both the fuel and span cylinder valves. Switch the analyser off.

5 OPERATION

5.1 Introduction

5.1.1 This section explains how to access all the features analyser's features. The fundamentals for basic operation are given in section 4, which should be used as a quick start to getting your concentration measurements.

5.1.2 The operational function of each key is given in section 6. Use it to find the full and exact key presses required to access a particular function. A fast method for setting values is explained in section 6.4.

5.1.3 The RS232 port is normally used when the analyser is part of a system and controlled by the Signal Host Controller. The commands for remote control via this port use the `AK' protocol and are detailed in section 8. Those wishing to control the analyser from a PC or other computer and have the facility for creating their own software should study that section.

5.2 Start-Up

5.2.1 Follow the instructions in section 3 for electrical and pneumatic installation. Follow the instructions in section 4 for making the analyser operational.

5.3 Display

5.3.1 The front panel will show the concentration in the best possible units for the selected range, automatically setting the decimal point as required. The bar graph under the numerical display shows the approximate fraction of the range used by the concentration value. This is a quick way to determine the need for a change in range. The concentration has exceeded the basic range if the numerical display and the bar graph are flashing. There is a 15% over-range capability on the display and chart outputs before accuracy is lost.

5.3.2 If too low a range is used with a high hydrocarbon concentration, the internal digital converter saturates. The concentration display will show '----' when this happens.

5.4 Range Controls

5.4.1 The concentration represented by a full scale on the chart recorder can be set using the [RANGE], [UP] and [DOWN] keys. Press [RANGE]. The display will show the concentration that will cause full scale output on the chart outputs. While the RANGE indicator is glowing, press [UP] or [DOWN] to select the required range.

5.4.2 When setting the range, a further press on the [UP] or [DOWN] key when at the highest or lowest range respectively, will set automatic range changing. This is shown as 'Auto' on the display.

5.4.3 Logic outputs and inputs, available on the front panel REMOTE connector, allow the analyser to report and control the range. Automatic ranging is not possible using these inputs. Refer to section 7 for full details on using this facility.

5.5 Sample

5.5.1 There are three gas paths used for measurement, SAMPLE, ZERO and SPAN. SAMPLE is used for sample concentration analysis. It is the only path that is fully heated to prevent loss of sample by condensation. Press the [SAMPLE] key to set this path. The SAMPLE indicator will glow.

5.5.2 If the oven is not at its working temperature, the ZERO path will be selected. The ZERO indicator will glow and the SAMPLE indicator will flash. When the oven is at its working temperature, the sample path will automatically change from ZERO to SAMPLE allowing sample measurement. This protects the sampling system from hydrocarbons condensing in a cold oven.

5.5.3 Logic outputs and inputs, available on the front panel REMOTE connector, allow the analyser to report and control the gas path. Refer to section 7 for full details on using this facility.

5.5.4 Gases entering via the SAMPLE path are filtered using a 0.4 micron (0.4 µm) glass-fibre filter to remove particulate the might block the sample path. This filter will require changing at intervals depending on the amount of particulate present in the sample. Refer to section 11.1 for filter replacement instructions.

5.6 Calibration

5.6.1 While in the SAMPLE mode, a full calibration of both zero and span can be started by pressing [CAL] and is confirmed when the CAL light glows. This will cause a zero calibration followed by a span calibration. The CAL light will turn off when the calibration is complete. During the zero calibration, the ZERO light will glow, and the display and chart outputs will show the offset on each range, starting at the highest and working down, prior to resetting them to zero. This allows any offset to be recorded and taken into account when evaluating the results. During the span calibration, the display and chart outputs will show the calibration range and any offset due to span drift. To cancel a calibration sequence before it finishes and updates the internal calibration constants, press [CAL]. The CAL light will turn off.

5.6.2 In order to perform a calibration, the analyser must be informed of the span gas concentration as indicated on the calibration certificate. When the analyser leaves the factory, a default value of 500 ppm is set for the calibration value. Press [SET][CAL] and the display will show the current value used for calibration. If this is not the same as that on the bottle certificate, press [UP] or [DOWN] to adjust it. Confirm the value with a final press on [SET]. Refer to sections 6.4 and 6.6 for full instructions on setting the calibration gas value.

5.6.3 It is possible to perform a zero calibration only. Press [ZERO][CAL] to perform a zero calibration only. The ZERO and CAL lights will glow. When the zero calibration has finished, the CAL light will turn off but the gas path will remain on ZERO. Press [SAMPLE] to return to the sample path.

5.6.4 It is possible to perform a span calibration only. Press [SPAN][CAL] to perform a span calibration only. The SPAN and CAL lights will glow. When the span calibration has finished, the CAL light will turn off but the gas path will remain on SPAN. Press [SAMPLE] to return to the sample path.

5.6.5 A calibration may fail if the wrong calibration gas value is entered, or if the internal amplifier or analogue to digital convertor response to the calibration gas is outside their working ranges. The calibration constants will not have been updated so that recordings can continue with the original constants. This condition is shown by a flashing CAL indicator and will remain until satisfactory calibrations are achieved or until the factory default calibration values are restored. To determine which calibration failed, press [ZERO] or [SPAN] and the ZERO or SPAN indicator will flash. If the calibration gas value is correct, and the bottle contents have been confirmed on another analyser, a calibration failure is an indication that a routine service should be performed by our service department. Refer to section 6.15 for instructions on restoring the factory default values.

5.6.6 Logic outputs and inputs, available on the front panel REMOTE connector, allow the analyser to report and control calibration. Refer to section 7 for full details on using this facility.

5.6.7 As part of the calibration procedure, the internal digital converter is independently calibrated. During this time (about 3.5 s) the concentration display will show '----' and the chart recorder output will be at full scale. This is additional confirmation for the start of the calibration process.

5.7 Concentration Alarms

5.7.1 Two alarms are available. HI-AL will flash, and a logic output on the front panel REMOTE connector will go low if the concentration is above the high alarm limit. LO-AL will flash, and a logic output on the front panel REMOTE connector will go low if the concentration is below the low alarm limit. The analyser is shipped with the alarms disabled. The alarm limits must be set before the alarms will function.

5.7.2 Alarm levels are set by pressing [SET]([HI-AL]or[LO-AL]) and the [UP] and [DOWN] keys to adjust the value. A display of '----' means that the alarm is disabled. Confirm the value with a final press on [SET]. Refer to sections 6.4, 6.10, and 6.11 for full instructions on setting the alarm values.

5.8 Non-Methane Option

5.8.1 An analyser can be fitted with an option to allow the measurement of methane and non-methane hydrocarbons.

5.8.2 An additional catalyst (cutter) is run at a particular temperature that selectively catalyses all hydrocarbons except methane. It effectively 'cuts' the non-methane hydrocarbons from the sample path. The catalyst is a high surface area platinum coating on a ceramic substrate. The platinum can be 'poisoned' by heavy metals such as lead, and silicone compounds. The non-methane option should not be used in applications where the sample gas may contain these contaminants.

5.8.3 The microprocessor controls the sample path so that the sample goes through the cutter for 30 s and bypasses the cutter for the next 30 s giving concentrations for Total Hydrocarbons and Methane. The Non-Methane content is calculated from the difference between them. The 'cutting' is not exact. Some Methane will be catalysed, and some of the other hydrocarbons will be left, after the sample is passed through the cutter. These cutter efficiency values are determined by an efficiency test and have been set during the factory calibration. The microprocessor uses these values to apply correction factors to the concentrations before outputting to the display or chart. These values can be changed from the front panel using the procedure in sections 6.12 and 6.13. Adjustment of the cutter temperature and determination of the efficiencies are best performed by our service department.

5.8.4 The [CH4], [TOT], and [NON] keys control the sample path and hence the mode of operation. The TOT mode bypasses the cutter and measures total hydrocarbon concentration. The CH4 mode uses the cutter and measures the methane concentration. The NON mode switches between the two modes and measures the non-methane concentration by subtracting the previous two values. The display shows the concentration of the selected mode. The TOT and CH4 modes output on their respective channels when selected; the other two channels are set to zero. All three concentrations are continuously available on the CHART outputs when in NON mode.

5.8.5 High and low alarm levels can be set for each mode. Only the alarm levels applicable to the selected mode will be active.

5.9 Fault Relay

5.9.1 A fault relay is de-energised when an error condition exists that prevents the analyser operating correctly. Its contacts are available on the front panel REMOTE connector. Refer to section 3 for installation instructions.

5.9.2 The most common error condition occurs when there is no power to the analyser. This could be due to a local power failure, mains lead not connected, mains power not switched on, fuse in mains plug faulty, or analyser fuse faulty.

5.9.3 The next most common error condition occurs when the flame is not lit. This condition causes the relay to turn off and an {E1} code to be flashed on the front panel display. Loss of flame can occur if the pump is not running, there is insufficient air supply, or if there is a problem in controlling the oven temperature.

5.9.4 The microprocessor constantly monitors many operational parameters and will display an {En} code if an error condition exists. Any {En} code will cause the fault relay to turn off. A list of error codes in given in section 9.

5.10 Converting To Other Units

5.10.1 The analyser is calibrated at the factory in Carbon Number equivalence using Methane in Air. The analyser can be calibrated in Propane equivalence.

5.10.1.1 Press [SET][SAMPLE]<[UP]and[DOWN]together>[SET] to restore the factory default calibration settings. Connect a calibration bottle containing a known level of Propane in Air (200 ppm to 5000 ppm is recommended but any concentration between 4 ppm to 10,000 ppm can be used) to the SPAN input port on the front panel. Select the lowest range that will include the cylinder concentration.

5.10.1.2 Press [ZERO] and adjust the ZERO control on the rear panel to display a concentration of zero.

5.10.1.3 Press [SPAN] and adjust the SPAN control on the rear panel to display the cylinder concentration.

5.10.1.4 Set the calibration value to the cylinder concentration by pressing [SET][CAL][UP]..[DOWN][SET] or by using the fast set facility.

5.10.1.5 Press [SAMPLE][CAL] and allow a normal calibration to proceed. Always use a propane calibration cylinder.

5.10.1.6 Calibration can be returned to Carbon Number equivalence by repeating the above procedure using the original methane in air cylinder.

5.10.2 The following conversion table gives the relationship between ppm and mg/m3 at STP (Standard Temperature and Pressure {101.3 kPa and 0 °C}) and ISA (International Standard Atmosphere {101.3 kPa and 15 °C}). The figures in each row are the concentration in alternative units.

ppm Methane	ppm Propane	mg/m^3 (STP)	mg/m^3 (ISA)
1	0.333	0.536	0.508
3	1	1.607	1.523
1.867	0.622	1	0.948
1.969	0.656	1.055	1

Unit Conversion Table

5.10.3 If you are using a chart recorder or data logger with an input scaling facility, it can be scaled to record in mg/m3.

5.11 Remote Control

5.11.1 The analyser can be placed in remote control by pressing [REM]. The REM light will flash unless a remote enable has been received via the RS232 line, or a logic enable line has been taken Low. Full descriptions of the remote operation are given in sections 8 for RS232 and 7 for logic control. Also refer to section 3 for installation requirements.

5.12 Hydrogen Fuel

5.12.1 Pure hydrogen may be used as a fuel where the oxygen content of the sample is close to that of normal air, and where it does not vary significantly during the monitoring period.

5.12.2 The use of hydrogen fuel requires changes to the sample and fuel flow-rates which can only be done at the factory. Contact our Service department or local representative.

6 ANALYSER CONTROLS

6.1 Philosophy

6.1.1 The front panel controls are based on function. There are no menu structures to complicate the display or set procedures. Most functions allow a parameter to be read and, using a second key, allow the parameter value to be changed or to perform a task.

6.1.2 As an example, a typical function is the [SPAN] key. If [SPAN] is pressed, the span gas is selected and the display will show the concentration. To perform a span calibration press [SPAN] followed by [CAL]. To enter the actual calibration gas concentration (from the bottle calibration certificate) press [SET], [SPAN], and the [UP] or [DOWN] keys until the display shows the required value, then complete the operation by a final press on [SET]. This intuitive data selection and entry method is easy to learn and leads to fewer mistakes.

6.1.3 For most functions, the display will resume showing the sample concentration if no key has been pressed for about 30s.

6.1.4 This section describes the function of each key and indicator. It makes use of the square brackets "[]" to show where a key press is required. As an example, the key to select Sample measurement would be shown as [SAMPLE]. It also makes use of the brace (or curly) brackets to indicate a warning number. As an example, a flame-out warning would be shown by {E1}. Flashing indicators are cautionary signals to show functions which are not ready or that have encountered their limit conditions.

6.1.5 An operational description of key sequences required for immediate operation is given in section 4, and for full use is given in section 5.

6.2 Basic Key Functios

6.2.1 [ON/OFF]

6.2.1.1 This is the main power and is used to turn the analyser on and off

6.2.2 [SAMPLE]

6.2.2.1 Selects the sample gas port for measurement. Sample will not be selected unless the oven is within ±15°C of the oven set point and the flame is lit. Until this condition exists, selecting sample leaves the zero gas active and will set the SAMPLE indicator flashing. As soon as the correct oven and flame conditions exist, the sample path will be selected. Used with the [CAL] key to perform both span and zero calibration.

6.2.3 [SPAN]

6.2.3.1 Selects the span gas port for measurement. Used with [SET] and [CAL] keys to calibrate the analyser.

6.2.4 [ZERO]

6.2.4.1 Selects the air inlet port for measurement. The air inlet port is fed to a catalytic convertor to remove hydrocarbons allowing normal ambient air to be used as a zero gas for most applications. Used with [SET] and [CAL] keys to set the zero point of the analyser.

6.2.5 [CH4]

6.2.5.1 This key selects Methane as a measurement and display mode (CH4). It is used with the [SET], [LO-AL], [HI-AL], [UP] and [DOWN] keys to set alarm trip levels for this mode, and with the [SET], [UP] and [DOWN] keys to set the Methane cut percentage. The key is disabled if the Non-Methane option is not fitted.

6.2.6 [TOT]

6.2.6.1 This key selects Total Hydrocarbon as a measurement and display mode (THC). It is the default mode if the Non-Methane option is not fitted. It is used with the [SET], [LO-AL], [HI-AL], [UP] and [DOWN] keys to set alarm trip levels for this mode, and with the SET], [UP] and [DOWN] keys to set the Propane cut percentage.

6.2.7 [NON]

6.2.7.1 This key selects Non-Methane as a measurement and display mode (NMHC). It is used with the [SET], [LO-AL], [HI-AL], [UP] and [DOWN] keys to set alarm trip levels for this mode. Non-Methane is the difference between the Total and CH4 modes. The analyser is automatically sequenced between these modes and the difference is calculated. This is transparent to the user. The key is disabled if the Non-Methane option is not fitted.

6.2.8 [IGN]

6.2.8.1 This key ignites the detector flame. While held, it enriches the fuel/air ratio for optimum ignition. It should be pressed for about four seconds to allow the enriched mixture to come in contact with the igniter. Ignition is not possible if the oven temperature is below 120°C. The key is inhibited until the oven temperature is above 120°C.

6.2.9 [RANGE]

6.2.9.1 Press to show the full scale range of the concentration display and chart recorder output. Used with the [UP] and [DOWN] keys to change the range. The displayed units will be PPM.

6.2.10 [CAL]

6.2.10.1 Press for three seconds to start a calibration. A zero calibration will be performed if zero gas path is in use, a span calibration will be started if the span gas path is in use, and both a zero and span calibration will be started if the sample gas path is in use. Any calibration can be cancelled by pressing [CAL] for a further three seconds. Calibration is inhibited if the flame is not lit. Used with the [SET], [UP] and [DOWN] keys to set an automatic calibration interval.

6.2.11 [TEMP]

6.2.11.1 Used to monitor the oven and convertor temperatures. A single press on this key shows either the oven or catalyst temperature, a second press (before the display reverts to concentration) shows the other temperature. The top right display will show units and the monitored item. A display of 'C 0V' is the oven temperature in °C, and 'C CA' is the catalyst temperature in °C. Used with the [SET], [UP] and [DOWN] keys to change a temperature control point. Nominal oven and convertor temperatures, and their adjustment ranges are given in section 2.

6.2.12 [UP]

6.2.12.1 Used to increase a parameter value or to select a higher (less sensitive) range when used with the [RANGE], [CAL], [TEMP], [SET], [HI-AL], or [LO-AL] keys. A fast set mode is available on most functions.

6.2.13 [DOWN]

6.2.13.1 Used to decrease a parameter value or to select a lower (more sensitive) range when used with the [RANGE], [CAL], [TEMP], [SET], [HI-AL], or [LO-AL] keys. A fast set mode is available on most functions.

6.2.14 [LO-AL]

6.2.14.1 Displays the low alarm trip point setting. A display of "----" means that the alarm is off. Used with the [SET], [UP] and [DOWN] keys to set the trip point.

6.2.15 [HI-AL]

6.2.15.1 Displays the high alarm trip point setting. A display of "----" means that the alarm is off. Used with the [SET], [UP] and [DOWN] keys to set the trip point.

6.2.16 [REMOTE]

6.2.16.1 Allows, or disables, control from a host computer via a serial link and 'AK' protocol, or from external logic inputs. This key must be pressed for more than three seconds to change the current control mode. The REMOTE indicator will be off if remote control is disabled, flashing if remote control is enabled but not activated, or on continuously if either serial or logic control is activated.

6.2.16.2 When serial link control is enabled, all front panel controls that change the analyser operation are disabled. It is still possible to view the analyser state (ie pressing [RANGE] shows the current range but it cannot be changed).

6.2.16.3 When external logic control is active, a remote enable for a function group will inhibit front panel control for that group. As an example, if remote range control is enabled, the range cannot be set from the front panel. It is still possible to view the analyser state.

6.2.16.4 An attempt to change an analyser state or parameter when under remote control will cause an {E30} code to be displayed.

6.2.17 [PUMP]

6.2.17.1 Control the operation of the internal pump. The pump must be on for ignition to be possible unless bottled air at pressure is connected to the AIR inlet port on the rear panel.

6.2.18 [SET]

6.2.18.1 Allows function values to be changed. Used as a prefix with [RANGE], [SPAN], [CAL], [TEMP], [HI-AL] or [LO-AL] keys. The [RANGE] key, used more frequently than other function adjustments, does not require (but will accept) the [SET] prefix. A final press on the [SET] key accepts the new data and returns to the previous measurement mode. The change can be abandoned by pressing [SAMPLE] prior to the final [SET]. The change will be abandoned if no key is pressed for thirty seconds.

6.3 Calibration Key Sequences

6.3.1 [SAMPLE][CAL]

6.3.1.1 Performs a full Zero and Span Calibration and uses the results to replace previous span and zero calibration details. The span gas concentration value (from the bottle calibration certificate) must have been previously entered. A further press on [CAL] before the calibration is complete cancels the operation without updating calibration details. The first press on [SAMPLE] is not necessary if already measuring sample gas.

6.3.1.2 The CAL indicator will flash if either (or both) zero or span calibration failed. If the zero calibration failed, the span calibration will not be attempted, but a span fail condition is recorded as though the calibration itself failed. To determine which calibrations failed, press [ZERO] and [SPAN] in turn.

6.3.1.2.1 The ZERO and CAL indicators will be flashing if the zero calibration failed. The span calibration was not attempted.

6.3.1.2.2 The SPAN and CAL indicators will be flashing if the span calibration failed or if the zero failed and span calibration was not attempted.

6.3.1.3 A valid zero and span calibration must have occurred before the calibration details are updated and the CAL indicator stops flashing. Both span and zero calibration details will remain at their previous levels if either span or zero calibration fails.

6.3.2 [SPAN][CAL]

6.3.2.1 Performs a Span Calibration only and uses the results to replace previous span calibration details. The span gas concentration value (from the bottle calibration certificate) must have been previously entered. Pressing [CAL] again before the calibration is complete cancels the operation without updating the span calibration details. The first press on [SPAN] is not necessary if already measuring span gas.

6.3.2.2 The SPAN and CAL indicators will flash if the calibration failed. The value from the previous calibration is used.

6.3.3 [ZERO][CAL]

6.3.3.1 Performs a Zero Calibration only and uses the results to replace previous zero calibration details. The analyser assumes that ALL hydrocarbons have been removed from the ambient air by the catalytic convertor. It may be necessary to connect the air inlet port to hydrocarbon-free bottled air if the hydrocarbon concentration in the ambient air is too high. Pressing [CAL] again before the calibration is complete cancels the operation without updating the span calibration details. The first press on [ZERO] is not necessary if already measuring zero gas.

6.3.3.2 Each analyser range is individually zeroed. The ZERO and CAL indicators will flash if any range failed the zero calibration and the values from the previous calibration are used.

6.4 Set Parameter Key Sequences

6.4.1 Parameter values such as alarms and calibration gas concentration are adjusted using the [SET] key. The general sequence is [SET][param]<[UP][DOWN]>[SET]. Press [SET], then the parameter key you wish to adjust (e.g. [HI-AL] or [LO-AL]), then the [UP] or [DOWN] keys until the display shows the required value, and finally the [SET] key to confirm the operation.

6.4.2 The above sequence is satisfactory if a minor adjustment to a value is to be made. Where large changes are necessary, a faster method for changing the value is available. The general form for this faster entry method is :-

[SET][param][param]<[UP][DOWN]>[param]<[UP][DOWN]>..[param]<[UP][DOWN]>[SET]

Press [SET], then the parameter key you wish to adjust, then the parameter key again. This sets the most significant digit flashing. Press [UP] or [DOWN] to adjust this digit. Press the parameter key again. The next less significant digit will flash. Press [UP] or [DOWN] to adjust this digit. A change from digit '9' to digit '0' will increment the next more significant digit. A change from digit '0' to digit '9' will decrement the next more significant digit. Press the parameter key again and repeat the sequence until all digits have been set. Press [SET] to confirm the value. This value will be used in all future calculations. If no change to a digit is required, press the parameter key to move to the next less significant digit.

6.4.3 Some parameters have maximum or minimum values that can be set. If a digit is changed that would take the value above the maximum or below the minimum, the display will show the maximum or minimum value.

6.4.4 To abandon a change for either method, press [SAMPLE] instead of the final [SET]. Any value on the display is ignored and the original value will be used in all future calculation.

6.4.5 A parameter value can be viewed by pressing [SET][param]. The display will show the current value. Press [SAMPLE] to revert to the concentration display.

6.4.6 If no key is has been pressed within the last thirty seconds, the operation is cancelled and the original value used in all future calculations.

6.4.7 Parameters can have special requirements or limitations to their use. All settable parameters are detailed below. All follow the general setting routines above unless otherwise stated.

6.5 Set Range

6.5.1 [RANGE] or [SET][RANGE]

6.5.1.1 The display shows the full scale concentration for the current range. Use the [UP] and [DOWN] keys to select a range. The display will show the full scale range in units of PPM. It is not necessary to press the [SET] key a final time to confirm selection. The displayed range will always be selected and the display will revert to concentration if no key is pressed within two seconds.

6.5.1.2 A further press on the [UP] key after the highest range, or a further press on the [DOWN] key after the lowest range sets the automatic range changing mode. The display will show 'Auto'. On exiting the set routine, the AUTO light will be on if Auto-range has been selected.

6.5.1.3 The fast change sequence is not necessary for this parameter and is not available.

6.5.1.4 When in AUTO mode, pressing [RANGE] will display the range in use as selected by the auto-range function and will resume concentration display after a few seconds. Pressing the [UP] key will select the lowest (most sensitive) range and exit from auto-ranging. Pressing the [DOWN] key will select the highest (least sensitive) range and exit from auto-ranging. Having exited the auto-range mode, use the [UP] and [DOWN] keys to choose a range.

6.6 Set Span Gas Concentration

6.6.1 [SET][SPAN]..[SET]

6.6.1.1 The analyser should be set to a range suitable for the calibration gas concentration to be measured. Acceptable values are from 80% of the next lower range, to 15% above the current range.

Range	Lower Limit	Upper Limit
0 - 4 ppm	0.8 ppm	4.6 ppm
0 - 10 ppm	3.2 ppm	11.5 ppm
0 - 40 ppm	8.0 ppm	46.0 ppm
0 - 100 ppm	32.0 ppm	115.0 ppm
0 - 400 ppm	80.0 ppm	460.0 ppm
0 - 1000 ppm	320.0 ppm	1150 ppm
0 - 4000 ppm	800.0 ppm	4600 ppm
0 - 10000 ppm	3200 ppm	11500 ppm

Span Gas Range Limits

6.6.1.2 On entry, the display will show the current span gas concentration. If the new concentration is to be on a different range, press [RANGE]<[UP][DOWN]> until the required range is selected. Wait for the display to revert to the setting mode. If the concentration is within the limits for that range, the same concentration value will be displayed. If it is outside the limits, the display will show the minimum for that range.

6.6.1.3 Set the value to that on the calibration gas bottle certificate.

6.6.1.4 If an [UP] or [DOWN] key is pressed that takes the value outside the limits for that range, the next higher or lower range will be selected. Continue setting the value for that range.

6.7 Set Automatic Calibration Period

6.7.1 [SET][CAL]..[SET]

6.7.1.1 The display shows the calibration period in hours and is adjustable in 0.1 h (6 min) intervals. A period of 0 disables automatic calibration.

6.8 Set Oven Temperature

6.8.1 <[TEMP]..[TEMP]> for oven temperature then [SET][TEMP]..[SET]

6.8.1.1 The nominal set point for oven temperature has been optimised for best performance. It should only be changed if instructed to do so by an authorised Signal representative or if you are experienced in the effects of temperature on the analyser performance.

6.8.1.2 The upper right hand display will show 'C OV' to indicate oven temperature in °C units. Adjust the temperature to suit your application. The oven temperature range limits are given in section 2.

6.9 Set Catalyst Temperature

6.9.1 <[TEMP]..[TEMP]> for catalyst temperature then [SET][TEMP]..[SET]

6.9.1.1 The nominal set point for catalyst temperature has been optimised for best performance. It should only be changed if instructed to do so by an authorised Signal representative or if you are experienced in the effects of temperature on the catalyst performance.

6.9.1.2 The upper right hand display will show 'C CA' to indicate catalyst temperature in °C units. Adjust the temperature to suit your application. The catalyst temperature range limits are given in section 2.

6.10 Set High Alarm

6.10.1 [SET][HI-AL]..[SET]

6.10.1.1 The high alarm trip point can be set anywhere in the measurement range of the analyser. A concentration higher than this value will set the High Alarm state. The highest point is 15% above the highest range (11500 ppm). A further press on the [UP] key when the highest point is set will turn the high alarm off and the display will show "----".

6.10.1.2 The Non-Methane option allows a high alarm trip point for each mode ([TOT], [NON], and [CH4]). Use [mode][SET][HI-AL] .. [SET] as required.

6.10.1.3 A fast way to turn the high alarm off is to reset to the factory default. Press [SET][HI-AL]<[UP]&[DOWN]together>[SET].

6.11 Set Low Alarm

6.11.1 [SET][LO-AL]..[SET]

6.11.1.1 The low alarm trip point can be set anywhere in the measurement range of the analyser. A concentration lower than this value will set the Low Alarm state. The highest point is 15% above the highest range (11500 ppm). A further press on the [DOWN] key when a value of 0 is set will turn the low alarm off and the display will show "----".

6.11.1.2 The Non-Methane option allows a low alarm trip point for each mode ([TOT], [NON], and [CH4]). Use [mode][SET][LO-AL] .. [SET] as required.

6.11.1.3 A fast way to turn the low alarm off is to reset to the factory default. Press [SET][LO-AL]<[UP]&[DOWN]together>[SET].

6.12 Set Propane Cut Percentage

6.12.1 [SET][TOT] .. [SET]

6.12.1.1 Set the propane cut percentage (PERC) as calculated during a cutter calibration procedure, or as given in the test sheet. A display of "2" means that 2% of the propane was left after passing through the cutter.

6.13 Set Methane Cut Percentage

6.13.1 [SET][CH4] .. [SET]

6.13.1.1 Set the methane cut percentage (PERC) as calculated during a cutter calibration procedure, or as given in the test sheet. A display of "98" means that 98% of methane was left after passing through the cutter.

6.14 Enable Automatic Ignition

6.14.1 [SET][IGN] .. [SET]

6.14.1.1 Use the [UP] or [DOWN] keys to toggle between enable and disable modes. A display of "----" shows that automatic ignition is disabled. A display of "0" to "4" shows that automatic ignition is enabled, and the value shows the number of ignition attempts made so far. The value is reset to zero if enable is toggled off and on, or if manual ignition is attempted.

6.15 Restore Factory Defaults

6.15.1 [SET][param]<[UP]and[DOWN]>[SET]

6.15.1.1 Each parameter value can be restored to its original factory setting using this key sequence. After the [UP] and [DOWN] keys have been pressed, the display will show the default setting. This can be changed using the [UP] or [DOWN] keys as required. Confirm the value with a final press on [SET].

6.15.1.2 Using [SAMPLE] as the parameter re-initialises the zero and span calibration values to no offset and unity span. This should be done during a routine service where the analyser electronics are calibrated. After the [UP] and [DOWN] keys have been pressed, the concentration display will show 'norL' in recognition of the key presses, and will show 'donE' when the final [SET] is pressed.

6.16 Indicators

6.16.1 General Numeric Display

6.16.1.1 This is located in the top area of the window and is used for all displays requiring a numeric value and units. The units are abbreviated to PPM (parts per million, 10-6), PERC (%), and C (°C, degrees Celcius).

6.16.1.2 It also shows any warning codes applicable by interrupting the concentration display after ten seconds and displays each code for a period of two seconds, and then reverts to concentration.

6.16.1.3 The concentration value will flash if it is past the upper limit for the range in use.

6.16.2 Chart Recorder Bar Graph

6.16.2.1 This is a horizontal bar graph immediately underneath the General Numeric Display and within the same window. It represents the fraction of the chart recorder range being used. For the Non-Methane option it can only show the fraction for the current displayed mode. If [NON] is selected, the bar graph will show the fraction of the Non-Methane channel.

6.16.2.2 The bar graph will flash if the concentration is above the upper limit for the range in use.

6.16.3 Gas Type

6.16.3.1 This shows the gas (or measurement mode) in current use. It is located in the bottom right of the window. It will flash if a high or low alarm is detected.

6.16.4 FAULT

6.16.4.1 This indicator glows when a fault or warning condition has been detected. The code will be flashed on the General Numeric Display for a period of two seconds and revert to concentration for ten seconds.

6.16.5 AUTO

6.16.5.1 This indicator glows when automatic range changing has been selected.

6.16.6 SAMPLE

6.16.6.1 This indicator glows when Sample gas is selected and its concentration is displayed. It will flash if Sample gas has been selected but, due to a cold oven, or loss of flame, cannot be allowed. Zero gas will be used until the correct conditions for Sample gas are present. The gas path will return to Sample as soon as analyser conditions allow.

6.16.7 SPAN

6.16.7.1 This indicator glows when Span gas is selected and its concentration is displayed, and while setting the span gas concentration. It will flash if the last span calibration failed.

6.16.8 ZERO

6.16.8.1 This indicator glows when Zero gas (air inlet port) is selected and its concentration is displayed. It will flash if the last zero calibration failed.

6.16.9 RANGE

6.16.9.1 This indicator glows when the display is showing range information.

6.16.10 CAL

6.16.10.1 This indicator glows when either manual or automatic calibration is in progress, and while setting the auto-cal interval. It will flash if the last calibration (zero or span) failed and until a valid calibration is achieved or the factory default calibration values are restored.

6.16.11 TEMP

6.16.11.1 This indicator glows when the display is showing temperature information and flashes if the displayed temperature (oven or catalyst) is outside the working limits.

6.16.12 SET

6.16.12.1 This indicator glows while parameter values are being changed.

6.16.13 LO-AL

6.16.13.1 This indicator glows if a low limit has been set for the current mode, and flashes if the measured value is less than the set value. The alarm is inhibited during calibration.

6.16.14 HI-AL

6.16.14.1 This indicator glows if a high limit has been set for the current mode, and flashes if the measured value is greater than the set value. The alarm is inhibited during calibration.

6.16.15 REMOTE

6.16.15.1 This alarm glows when either serial or logic remote control is active, and flashes if remote control has been selected but is not active.

6.16.16 PUMP

6.16.16.1 This indicator glows when the internal sample/air pump is switched on.

6.16.17 IGN

6.16.17.1 This indicator glows when the detector flame is present, and while the auto-ignition state is being set. It will flash when the ignition button is pressed and until a flame can be detected. If no flame is detected within 1 min, and provided that all auto-ignition attempts have been made, the indicator will turn off.

6.16.18 TOT

6.16.18.1 This indicator glows when measuring Total Hydrocarbons or when setting the Propane Cut Percentage.

6.16.19 NON

6.16.19.1 This indicator glows when measuring Non-Methane Hydrocarbons.

6.16.20 CH4

6.16.20.1 This indicator glows when measuring Methane or when setting the Methane Cut Percentage.

7 LOGIC REMOTE CONTROL

7.1 Description

7.1.1 A computer with a digital I/O capability and running dedicated software, or a series of switches and indicators, can be used to control the most frequently required functions and display the analyser state. The control is not as comprehensive as that provided by serial remote control.

7.1.2 Range, gas path, analyser mode, auto-cal and sleep can be set. The readiness state, range, gas path, mode, high and low alarm states, calibration progress and the analyser fault condition can be monitored.

7.1.3 Logic remote control is enabled by pressing [REMOTE] on the front panel. If the serial remote control is connected and the SREM command has been sent, the logic commands will be ignored. Sending the SMAN command will restore control to the logic inputs.

7.1.4 Logic inputs are coded for contact closure use. Inputs left open circuit are regarded as OFF. Only those functions required need be wired since the others will default to OFF. This type of coding is often called 'negative logic' because a 'Low' level is TRUE and a 'High' level is FALSE. Voltages from 5 V TTL or CMOS logic can be used to code the inputs. Due to the negative logic, a 'Low' voltage is TRUE and a 'High' voltage is FALSE. Refer to section 2 for input restrictions and to section 3 for wiring and typical interfacing methods.

7.1.5 Logic outputs are also coded in negative logic. A TRUE state is a 'low' voltage and a FALSE state is a 'high' voltage. Refer to section 2 for input restrictions and to section 3 for wiring and typical interfacing methods.

7.1.6 The range, gas path, and mode selections are encoded to reduce the number of lines needed to control them.

7.2 Range Control and Indication

7.2.1 Range is shown by the state of three output lines RO0, RO1, and RO2. They are encoded in binary using negative logic. Range is controlled by the state of three digital input lines RI0, RI1, and RI2. These are also coded in binary using negative logic. A further input REN (remote enable) must be held 'low' (TRUE) to enable range control. The codes are the same for both output and control and are given in the following table.

	Range	RI2 or RO2	RI1 or RO1	RI0 or RO0
1	0-4 ppm	Low	Low	Low
2	0-10 ppm	Low	Low	High
3	0-40 ppm	Low	High	Low
4	0-100 ppm	Low	High	High
5	0-400 ppm	High	Low	Low
6	0-1000 ppm	High	Low	High
7	0-4000 ppm	High	High	Low
8	0-10000 ppm	High	High	High

Range Control Logic

7.3 Gas Path Control and Indication

7.3.1 Gas path is shown by the state of two output lines GPO0 and GPO1. They are encoded in binary using negative logic. Gas path is controlled by the state of two digital input lines GPI0 and GPI1. These are also coded in binary using negative logic. A further input line GPEN (gas path enable) must be held 'low' (TRUE) to enable gas path control. The codes are the same for both output and control and are given in the following table.

Gas Path	GPI1 or GPO1	GPI0 or GPO0
Sample	High	High
Zero	High	Low
Span	Low	High
Sample	Low	Low

Gas Path Control Logic

7.4 Analyser Mode Control and Indication

7.4.1 The mode control is only operational if the Non-methane option is fitted. It allows the selection of total, methane, and non-methane modes of operation.

7.4.2 The default mode for the output lines of a standard analyser is total (only one mode possible). Codes on the input lines are ignored. The enable line is ineffective.

7.4.3 Analyser mode is shown by the state of two output lines MO0 and MO1. They are encoded in binary using negative logic. Analyser mode is controlled by the state of two digital input lines MI0 and MI1. These are also coded in binary using negative logic. A further input line MEN (mode enable) must be held 'low' (TRUE) to enable mode control. The codes are NOT the same for both output and control. Both inputs held low is an invalid code and is interpreted as TOT. The returned code is that for the TOT mode. The codes are given in the following table.

Analyser Mode	MI1	MI0	MO1	MO0
Total (TOT)	High	High	High	High
Methane (CH4)	High	Low	High	Low
Non-methane (NON)	Low	High	Low	High
Total (TOT)	Low	Low	High	High

Mode Control Logic

7.5 Calibration Control and Indication

7.5.1 Calibration is controlled by the ACAL (auto-cal) and GPEN (gas path enable) input lines. The progress through the calibration procedure is shown by the CIP (calibration in progress), READY, and CFAIL (calibration fail) output lines.

7.5.2 A calibration can be started by taking the ACAL input Low for a minimum period of two seconds then returning it High. The type of calibration will depend on the gas path selected. Zero gas path causes a zero calibration, span gas causes a span calibration, and sample gas causes both zero and span calibration. If no GPI lines are used, both zero and span calibrations will be performed.

7.5.3 Taking the GPEN line Low disables the front panel [CAL] key in addition to the gas path selection keys. Calibration is only possible from the ACAL input line.

7.5.4 A calibration can be stopped while in progress by taking the ACAL input Low for a minimum of two seconds the returning it High. The calibration details will not be updated.

7.5.5 While calibration is in progress, the CIP output will go Low and the READY output will go High.

7.5.6 If the calibration fails, the CFAIL output will go Low and remain there until a satisfactory calibration is obtained, or until the factory default values are restored.

7.6 High and Low Concentration Alarms

7.6.1 HIAL and LOAL are two outputs representing the state of the high and low alarms. A Low level on the HIAL line indicates that the concentration is above the high alarm trip value, and a Low level on the LOAL line indicates that the concentration is below the low alarm trip value.

7.6.2 When the Non-methane option is fitted, alarms can be set for each of the three modes (TOT, NON, CH4). The HIAL and LOAL outputs refer to the selected mode only using the thresholds set for that mode.

7.7 Sleep Mode Control

7.7.1 If the SLEEP input is taken Low, the analyser is placed into a 'sleep' or 'standby' mode. The pump and fuel will be turned off. Oven and Catalyst temperatures will be maintained. When the SLEEP input is released (or taken High) the pump and fuel will be switched on. If auto-ignition was enabled, automatic re-ignition will occur allowing the analyser to become active within a few minutes.

7.8 Fault Relay

7.8.1 Relay contacts are available for warning of a fault condition within the analyser. The FRCOM (common) contact will be connected to the FRNC (normally closed) contact when there is no power to the analyser and when there is a fault or error condition. The FRCOM (common) contact will be connected to the FRNO (normally open) contact when power is present and there is no fault or error condition detected.

8 SERIAL PORT REMOTE CONTROL

8.1 Description

8.1.1 A Signal Host, or other computer with at least one serial port and running dedicated software, can be used to control and interrogate the analyser. An RS232 serial port on the computer is connected to the serial port on the analyser and is used to transfer commands from the computer to the analyser, and the responses from the analyser to the computer. Up to eight analysers can be connected to the computer provided that there are enough serial ports and drivers.

8.1.2 The computer and analyser 'talk' to each other using a very structured protocol to ensure that commands cannot be misunderstood.

8.1.3 The remote control protocol follows the standard known as `AK' which has been specified by the German automobile industry. It is based on the master/slave principle. The host computer is the master and the analysers are the slaves. Each analyser is connected to the host via an individual RS232 link. The host (master) issues a command `packet' to an analyser (slave), the analyser processes the data and responds with an acknowledgement packet. The analyser cannot transmit any data to the host other than as an acknowledgement packet.

8.1.4 The analyser is placed in remote control by using the [REMOTE] button on the front panel AND by sending the serial SREM command. Remote control via the serial port has a higher priority than logic control and will over-ride any logic control inputs. Control can be restored to the logic inputs by sending the serial SMAN command. Pressing the front panel [REMOTE] command a second time restores control to the front panel. The full sequence of pressing [REMOTE] and sending the serial SREM command is necessary to restore serial control.

8.1.5 When the analyser is in local mode, it will respond correctly to any interrogation command. A set command will return the 'off-line acknowledgement'.

8.1.6 When the analyser is in remote control, it will respond correctly to both interrogation and set commands.

8.2 General Packet Format

8.2.1 The general form of every packet is as follows:

<STX><x><CODE>[.. data field ..] <ETX>

Where:
<STX> Ascii STX
<ETX> Ascii ETX
<CODE> 4 Ascii Character Command code
x is a don't care byte that is read from DIP switches in the equipment.

8.2.2 All characters transmitted are standard ASCII printable characters except for the following:

<STX> Ascii STX (Decimal 2, or Hex 02)
<ETX> Ascii ETX (Decimal 3, or Hex 03)
<CR> Ascii carriage return (Decimal 13, or Hex 0D)
<LF> Ascii line feed (Decimal 10, or Hex 0A)

8.3 AK Command Packet

8.3.1 `Commands' and `data' packets are transmitted from the MASTER to a SLAVE.

8.3.2 <STX><x><CODE><space><K><n><space>[...data...]<ETX>

Where: K = Ascii character `K'
n = A single digit, 0-9, indicating channel number.

From the Signal Host to the Analysers, n is always 0.

8.4 AK Acknowledgement Packet

8.4.1 Acknowledgement messages are transmitted from a SLAVE to the MASTER as an acknowledgement to a command packet from the master.

8.4.2 The general form of an acknowledgement is

<STX><x><CODE><space><error>[.. data field ..]<ETX>

Where: space = Ascii space character.

Error = A one byte indication of the state of the equipment.

Ascii `0' = No errors.
Ascii `1' - `9' = cyclic count of errors increasing with each error and decreasing when each error is cleared. Eg: `1' can mean 1 or 10 or 19 errors.

CODE = The code of the command that was sent if it was understood. If received code was not understood, CODE in the acknowledgement will contain four question marks, i.e. ????.

Data field = Dependent upon the command issued.

8.4.3 There are various different acknowledgement packets.

OK Acknowledgement

If the received command was understood and processed by the slave the format of the acknowledgement is :-

<STX><x><CODE><space><error>[data]<ETX>

Where the data area contains the response to the command.

Offline Acknowledgement

If the Analyser is `offline' i.e. not in `remote' mode the acknowledgement is:-

<STX><x><CODE><space><error><space><K><0><space><0><F><ETX>

The command will be ignored.

Busy Acknowledgement

If the Analyser is `busy' i.e. not ready to accept and process a new command, the acknowledgement is :-

<STX><x><CODE><space><error><space><K><0><space><B><S><ETX>

The command will be ignored.

8.4.4 The Data Field

The data field may be from 0 to 99 characters long. Every data value will be preceded by a space. <CR> and <LF> characters may also be used as separators.

8.5 AK Codes

8.5.1 SRES Reset
data = NA
results = NA
Used by: Analyser/host/gas divider

8.5.2 STBY Standby (Flame off, pump off, oven and catalyst at temperature)
data = NA
results = NA
Used by: Analyser/host/gas divider

8.5.3 SPAU Pause
data = NA
results = NA
Used by: Analyser/host/gas divider

8.5.4 SARE Auto-range On
data = NA
results = NA
Used by: Analyser

8.5.5 SARA Auto-range Off
data = NA
results = NA
Used by: Analyser

8.5.6 SEMB Set Range
data = Mx x = 0 for auto-range
results = NA x = range number
Used by: Analyser

8.5.7 SMGA Set Sample gas
data = NA
results = NA
Used by: Analyser/host

8.5.8 SNGA Set Zero gas
data = NA
results = NA
Used by: Analyser/host

8.5.9 SEGA Set Span gas
data = NA
results = NA
Used by: Analyser/host

8.5.10 SATK Calibrate (equivalent to front panel [SAMPLE][CAL])
data = NA
results = NA
Used by: Analyser/host

8.5.11 SREM Enable Serial Remote Control
data = NA
results = NA
Used by: Analyser/host/gas divider

8.5.12 SMAN Disable Serial Remote Control
data = NA
results = NA
Used by: Analyser/host/gas divider

8.5.13 SMFR Set NON mode (only possible with the non-methane option)
data = NA
results = NA
Used by Analyser

8.5.14 SHCG Set TOT mode (total hydrocarbon)
data = NA
results = NA
Used by: Analyser

8.5.15 AKON Return Measured Value (as shown on the front panel display)
data = NA
results = ffff.fffff
Used by: Analyser

8.5.16 AANG Return Zero point error "Range, Value, PPM Error, %Error"
data = NA
results = Mx xxxx.xxx xxxx.xxx xx for each range
Used by: Analyser

8.5.17 AAEG Return Full scale error "Range, Value, PPM Error, %Error"
data = NA
results = Mx xxxx.xxx xxxx.xxx xx for each range
Used by: Analyser

8.5.18 ASTF Return Error Status: Equipment error code(s)
data = NA
results = x x x ... list of all current error codes
Used by: Analyser

8.5.19 AEMB Return Selected Range: Current analyser range
data = NA
results = Mx x=1 to 8
Used by: Analyser

8.5.20 AMBE Return Range Full Scale "Range, FSD"
data = NA
results = MX xxxx.xx xxxx.xx ... in ppm for each range
Used by: Analyser

8.5.21 AMBU Return Auto-range Threshold "Range, Lower, Upper"
data = NA
results = Mx xxxx.xx xxxx.xx ... in ppm for each range
Used by: Analyser

8.5.22 AKAK Return Calibration gas concentration "Range, Cal Gas"
data = NA
results = Mx xxxx.xxx
Used by: Analyser

8.5.23 ATEM Return Temperature (oven)
data = NA
results = xxxx (xxxx in degrees kelvin)
Used by: Analyser

8.5.24 AUKA Return Uncorrected values "Range, uncorrected analogue value"
data = NA
results = Mx adc=ñxxxxx
Used by: Analyser

8.5.25 EKAK Set calibration gas concentration "Range, Concentration"
data = Mx Span=xxxx.xx concentration in ppm
results = NA
Used by: Analyser

8.5.26 GKON Return Measured Values
data = NA
results = tttt.tttt (TOT) for standard analyser, or
cccc.cccc tttt.tttt nnnn.nnnn (CH4, TOT, NON) if non-methane option fitted.
Used by: Analyser

8.5.27 GRAN Return Model, Serial No. and Gas Data
data = NA
results = Model=x Gases=x Serial#=xxxx
Used by: Analyser

8.5.28 GRAV Read average, max and min concentrations
data = NA
results = AV=fffff.fff MX=gggg.gggg MN=hhhhh.hhhh
ffff.fff average reading.
gggg.ggg Minimum reading.
hhhh.hhh Maximum reading.
Used by: Analyser

8.5.29 GRAD Read average and alignment delay
data = NA
results = Av=X D0=X D1=X
X= time in 0.1 seconds
Used by: Analyser

8.5.30 GSAD Set average and alignment delay
data = Av=X D0=X D1=X
results = NA
X= time in 0.1 seconds
Used by: Analyser

8.5.31 GRLG Read the alarm limits
data = Gx
results = Gx Low=xxx High=xxxx
x= 0,1,2 for the gas, xxx= limit in ppm
Used by: Analyser

8.5.32 GSLG Set the alarm limits

data = Gx Low=xxx High=xxxx

x= 0,1,2 for the gas, xxx= limit in ppm

results = NA

Used by: Analyser

8.5.33 GRAL Read alarms (high, low, span, zero, temperature)

data = NA

results = LA=a HA=b ZA=c SA=d TA=e

a=low concentration alarm status

b=high concentration alarm status

c= zero cal alarm status

d=span cal alarm status

e= temperature alarm status

Used by: Analyser

8.5.34 GRCL Read calibration state

data = NA

results = CS=a ZS=b SS=c

a= calibration status

0=Not calibrating

1=Zero calibrating only

2=Span calibrating only

3=Zero calibrating before span

4=Not calibrating Basic data installed

b= zero calibration status

0=No zero calibration

1=Last Zero calibration Successful

2=Last Zero calibration Unsteady

3=Last Zero calibration Outside limits

c= Span calibration status

0=No Span calibration

1=Last Span calibration Successful

2=Last Span calibration Unsteady

3=Last Span calibration Outside limits

Used by: Analyser

8.5.35 GRGE Read cutter efficiencies

data = NA

results = FO=aa F1=bb

aa = Gas 0 (CH4) efficiency

bb = Gas 1 (TOT) efficiency

8.5.36 GSGE Set cutter efficiencies

data = FO=aa F1=bb

results = NA

aa = Gas 0 (CH4) efficiency

bb = Gas 1 (TOT) efficiency

8.5.37 GRAR Return Auto-ignition state, count, max
data = NA
results = RS=a RC=b MR=c
a=status ON/OFF 1/0
b=Current ignition count
c=Maximum allowable re-ignition.
Used by: Analyser

8.5.38 GSAR Set Auto-ignition state
data = io=(0/1) 1=ON
results = NA
Used by: Analyser

8.5.39 GSIS Set Ignition on or off
data = io=(0/1) 1=ON 0=OFF
results = NA
Used by: Analyser

8.5.40 GSPS Set Pump on or off
data = io=(0/1) 1=ON 0=OFF
results = NA
Used by: Analyser

8.5.41 GSTS Set Temperature (oven)
data = T=nnn (nnn in degrees kelvin)
results = NA
Used by: Analyser

8.5.42 GSAC Abandon the calibration
data = NA
results = NA
Used by: Analyser

8.5.43 GRFS Return the Flameout state
data = NA
results = io=(0/1) 1=Flame out
Used by: Analyser

8.5.44 GRPS Return the Pump state
data = NA
results = io=(0/1) 1=ON
Used by: Analyser

8.5.45 GSCT Set the Auto-cal time
data = ATnnn - nnn in 6min (0.1h) units
results = NA
Used by: Analyser

8.5.46 GRCT Return the Auto-cal time
data = NA
results = ATnnn - nnn in 6min (0.1h) units
Used by: Analyser

8.5.47 GRTS Return the Temperature (oven) set point
data = NA
results = T=xxx (xxx in degrees kelvin)
Used by: Analyser

8.5.48 GRWG Return Which Gas CH4, TOT, NON
data = NA
results = Gx
x=Gas number 0=CH4, 1=TOT, 2=NON
Used by: Analyser

8.5.49 GRMW Return Which Gas path SAMPLE, ZERO, SPAN
data = MA
results = me=x
x=path 0=SAMPLE, 1=ZERO, 2=SPAN
Used by: Analyser

8.5.50 GRSS Return System State
data = NA
results = Gx me=a Mb Conc=b AvC=c CS=d ZS=e SS=f LA=g HA=h ZA=i SA=j TA=k NF=1

x = which gas number 0, 1, 2. see GRWG
a = which gas route 0, 1, 2. see GRMW
b = the instantaneous reading in ppm.
c = The average reading in ppm.
d = The calibration status. see GRCL
e = The zero calibration status. see GRCL
f = The span calibration status. see GRCL
g = The low alarm status. see GRAL
h = The high alarm status. see GRAL
i = The zero alarm status. see GRAL
j = The span alarm status. see GRAL
k = The temperature alarm status. see GRAL
l = The number of faults.
Used by: Analyser

8.5.51 GMET Set CH4 mode (only possible with the non-methane option)
data = NA
results = NA
Used by: Analyser

8.5.52 GRXS Return Temperature (catalyst) set point
data = NA
results = T=xxx (xxx in degrees kelvin)
Used by: Analyser

8.5.53 GSXS Set Temperature (catalyst)
data = T=nnn (nnn in degrees kelvin)
results = NA
Used by: Analyser

8.5.54 GTEM Return Temperature (catalyst)
data = NA
results = T=xxxx (xxxx in degrees kelvin)
Used by: Analyser

9 FAULT CODES

9.1 Health Check

9.1.1 The microprocessor continuously monitors the state, or health, of the analyser. If a condition is detected that the user should be made aware of, a warning will be displayed in the form of an "E" number. Some warnings are not due to an analyser failure, but indicate that the analyser is not ready.

9.2 Digital (logic)

E 1 Flame out
E 2 Watchdog timer reset
E 3 Invalid Linearisation Data
E 4 Error writing to EEPROM
E 5 ADC Calibration fault
E 6 Invalid Configuration Data
E30 Manual Function Inhibited

9.3 Analogue

E 9 Battery failure
E10 FID bias voltage error
E11 Power supply error

9.4 Internal control

E20 Oven temperature outside working limits
E21 Internal temperature outside working limits
E24 Catalyst temperature outside working limits

9.5 Hardware faults

E64 - E79 Fault in PIO
E144 - E159 Fault in ADC
E160 - E175 Fault in EEPROM
E901 Fault in RAM
E902 Fault in EPROM
E903 Checksum error in EEPROM

These codes normally prevent analyser operation.

10 TECHNICAL DESCRIPTION

10.1 The Flame Ionisation Detector

10.1.1 The Model 3030PM Portable Heated Hydrocarbon Analyser is based on the Flame Ionisation Detector (FID). The flame ionisation detector works by ionising the sample gas using combustion in a hydrogen flame. Ions produced in this process are collected at a polarized electrode outside the combustion zone. The polarizing voltage across the detector must be high enough to stop any recombination of the electrons and positive ions produced in the flame. If the voltage is too low, all of the electrons may not reach the collector electrode causing insensitivity and, with larger samples, non-linearity. The resultant electrical current, proportional to the mass of carbon present in the flame, is in the order of 1 pA (10-12 A) to 100 nA (10-7 A). It is then amplified to produce the analyser signal.

10.1.2 When the sample gas is composed of gases of different carbon number, the detector will respond to the number of carbon atoms present. As an example, air containing 10 ppm methane and 10 ppm propane will produce a reading of 40 ppm carbon atoms and is numerically equal to 40 ppm methane equivalent. The user may calibrate the analyser with a methane or propane standard; all readings will then be either methane or propane equivalent, respectively.

10.1.3 An important characteristic of the flame ionisation detector is the variation in detector response with changes in oxygen concentration in the sample gas. This effect is normally only found in the analysis of combustion gases. It requires a special fuel consisting of 40% hydrogen and 60% helium. To compensate for the lower concentration of hydrogen, an analyser using a hydrogen/helium mix requires a greater (x3) fuel flow. Each analyser is built to be used with a specific fuel option. A 100% hydrogen fuel is used for applications rich in oxygen. The fuel capillary may be changed to the alternative option and this may be arranged through the local Signal sales office or distributor.

10.2 Catalytic Air Purifier

10.2.1 In order to give a stable signal, the FID requires a supply of clean, hydrocarbon-free air. As an aid to portability, the analyser air is supplied from a built-in pump. As there is a possibility of the ambient air being contaminated with hydrocarbons, it is passed over an internal platinum catalyst on an alumina substrate at high temperature. Air passed through the catalytic air purifier is also used as zero gas during calibration.

10.3 Detector Gas Control

10.3.1 The stability of the air and fuel flows to the detector are important to maintain detector stability and sensitivity. The optimum performance of the detector is particularly dependent on the ratio of hydrogen to sample gas flow rate, since this ratio affects the flame temperature and therefore the ionisation efficiency. The ratio of air to fuel is set at 10:1. The gas flows are fixed at the factory and should not require adjustment. If adjustment should be necessary, it should only be carried out during service by an authorized service engineer. The fuel mixture is automatically enriched during ignition.

10.3.2 The Model 3030PM has a facility for the automatic ignition of the FID. This facility can be enabled from the front panel. When enabled, an ignition procedure will be started whenever the flame is out, provided that the oven is at temperature and the analyser is ready to run. Should the flame fail to ignite, the fuel valve is switched off. This feature is necessary where unattended operation is required and the mains supply cannot be guaranteed.

10.4 Sample/Bypass System

10.4.1 The small sample flow rate (about 8 ml/min) to the detector would give an impossibly long response time if it were not used with a bypass system. The bypass system uses a high sample flow rate (about 5 l/min) to give a rapid turnover of sample gas and therefore a rapid response time. Most of the sample gas is dumped but a very small proportion of the gas is passed to the detector.

10.4.2 As the flame ionisation detector is mass sensitive, that is, its response is proportional to the total mass of hydrocarbon entering the detector per unit time, any changes in pressure in the sample system brought about by changes in sample flow rate will have a directly proportional effect on detector response.

10.4.3 The analyser uses air from the sample/air pump to compensate for variations in sample flow to maintain a constant pressure in the sample system and a constant flow to the detector. The bypass air is added to the sample flow after the sample take-off point to the detector and therefore does not dilute the sample. The constant pressure maintained in the sample system by the back pressure regulator produces a constant flow through the orifice at the vent outlet, composed of a mixture of sample and bypass air. Excess bypass air exits the analyser via the bypass vent and the back pressure regulator. This system ensures that no sample gas comes into contact with the back pressure regulator. Problems associated with contamination of the regulator by the sample gas and exposing the regulator to high temperatures are therefore avoided.

10.5 Heated Sample Manifold

10.5.1 The analyser incorporates a heated sample system and detector which maintains a sample temperature of up to 200 °C. The upper temperature is adjustable, over a fixed range, by the user. For applications where hydrocarbons with high boiling points are required to be measured, high temperature heated lines are necessary to maintain high temperatures within the entire sample system. The analyser is supplied with a 5 m line and controller.

10.5.2 The sample manifold in the Model 3030PM is controlled to within ±1 °C of the set temperature, by sensing with a thermocouple and using a proportional band temperature controller. The control system is designed to maintain the sample capillary, which is attached directly to the sample manifold, at a very steady temperature in order to minimise detector drift.

10.5.3 The sample manifold houses a 0.4 micron (0.4 µm) glass fibre filter, secured with a bayonet-type fixing. The filter will prevent particulate matter entering the sample system. The sample gas then passes through a solenoid valve, which is attached to the sample manifold and therefore heated. This valve is used to switch off the sample flow when calibration is required. The sample pump head is also incorporated into the heated sample manifold to prevent sample condensation.

10.5.4 Bypass air is supplied by the second head of the sample pump. Hydrocarbon-free air for the FID and zero gas is supplied by passing a portion of the bypass air supply through the catalytic air purifier.

10.6 Safety and Flame-out Alarm

10.6.1 The analyser is designed to minimize the possibility of a dangerous build up of fuel gas. It is ventilated so that any possible fuel leak cannot collect inside. The fuel solenoid is also shut when the analyser is switched off. If the FID flame is extinguished during use and subsequent attempted automatic re-ignition is unsuccessful, the fuel solenoid will close and remain closed until the operator intervenes.

10.7 Methane/Non-methane Measurement

10.7.1 Air pollution studies require the measurement of total hydrocarbons in order to correlate hydrocarbon emissions with ozone and nitrogen oxides. Since methane is commonly produced by biological processes, some applications require the ability to measure methane and non-methane hydrocarbons separately. This can be carried out with the Model 3030PM, using the platinum cutter option.

10.7.2 There are two possible paths for the sample gas in an analyser fitted with the platinum cutter option. One path bypasses the cutter while the other passes through it. While the sample is being passed directly to the detector, the total hydrocarbon content of the sample gas is being measured. When the sample gas passes through the cutter, the methane content only of the sample gas is being measured. Automatically subtracting the methane content from the total hydrocarbon content gives the non-methane content.

11 ROUTINE MAINTENANCE

11.1 Filter Replacement

CAUTION

If the analyser has been switched on, the filter housing will be too hot to touch. The filter replacement tool provides a method for changing hot filter elements

Dirty filters may contain corrosive compounds.

Use gloves

11.1.1 Disconnect the sample gas line. The filter is immediately underneath the pipe fitting. The pipe fitting and filter cap are removed as a single item using a special tool.

11.1.2 Identify the filter extraction tool in the accessory kit. It has a "T" bar at one end.

11.1.3 Using the filter extraction tool, release the filter cap by rotating ¼ turn anti-clockwise. Reverse the tool and screw it onto the pipe fitting. Withdraw the housing taking care not to touch any hot surfaces.

11.1.4 The filter element will be found protruding from the cap. It will quickly cool and may be removed by hand. Dirty filters may contain corrosive compounds. Use gloves.

11.1.5 Fit a new filter element. Filter elements are available from Signal in packs of ten under the part number FILT/010. If you purchased a 1 year spares kit with the analyser, a pack of filters was included.

11.1.6 Re-assemble the filter cap to the analyser using the reverse procedure and reconnect the sample line.

11.2 Calibration

11.2.1 Regularly perform a span and zero calibration. Allow the instrument to warm up fully before the calibration is checked. If the analyser is in continuous use, consider using the automatic calibration facility.

11.2.2 The frequency of calibration checks depends on the degree of accuracy expected from the instrument, the conditions under which it is being used and its mode of operation. Calibration every four days (96 hours) is recommended for normal operation under good conditions, if the analyser is left running for 24 hours per day. Once per day is recommended if the analyser is switched off overnight, or if barometric pressure compensation is desired.

11.3 Cutter Efficiency

11.3.1 At intervals of about three months, or more frequently if required, check the efficiency of the methane cutter. An additional calibration bottle of 1000 ppm Propane in air is required.

11.3.2 Allow the analyser to warm up and stabilise and enter the methane span gas concentration from the cylinder certificate. Make a separate note of the value. Perform a normal full calibration using the 500 ppm Methane in air cylinder by pressing [SAMPLE][CAL]. Select automatic range changing.

11.3.3 Connect 1000 ppm Propane in air to the SPAN port, press [TOT][SPAN], wait for the reading to stabilise, and note the concentration reading. The concentration will be in the order of 3000 ppm if you have previously calibrated in methane equivalent concentration. Press [CH4] and adjust the CUTTER control on the rear panel until the concentration is 15% of the original reading. Note this value. Note the propane percentage remaining.

11.3.4 Connect the 500 ppm Methane span gas to the SPAN port and wait for the reading to stabilise. Check that the concentration is greater than 85% of the certificate value. Note the methane percentage remaining.

11.3.5 Enter the propane percentage by pressing [SET][TOT]..[SET] and the methane percentage by pressing [SET][CH4]..[SET]. Refer to sections 6.12 and 6.13 for full instructions.

11.3.6 If the requirement for 15% or less of propane and 85% or more of methane residues cannot be achieved it is possible that the cutter has become 'poisoned'. Poisoning can often be reversed by setting the cutter control full clockwise, pressing [CH4][ZERO], and leaving for twenty-four hours. If a satisfactory performance cannot be obtained, a full service is required, during which the cutter must be replaced.

12 ROUTINE SERVICING

12.1 Schedule

12.1.1 Servicing should be carried out every 2700 hours of use and involves cleaning the detector and gas paths, filter replacement, electronic calibration, linearity and drift tests. We recommend that all servicing is carried out by our Service Department or approved distributors and agents.

12.2 Service Manual

12.2.1 Full Maintenance Manuals are normal issued to distributors and service agents only, but can be purchased by customers if they wish to carry out their own servicing. All warranty will cease however, if a customer carries out his own servicing during the warranty period unless special arrangements have been made in writing. If you wish to carry out your own servicing, contact Signal, your local distributor or agent to discuss the implications and ask for Part Number 3030PM/SERV.

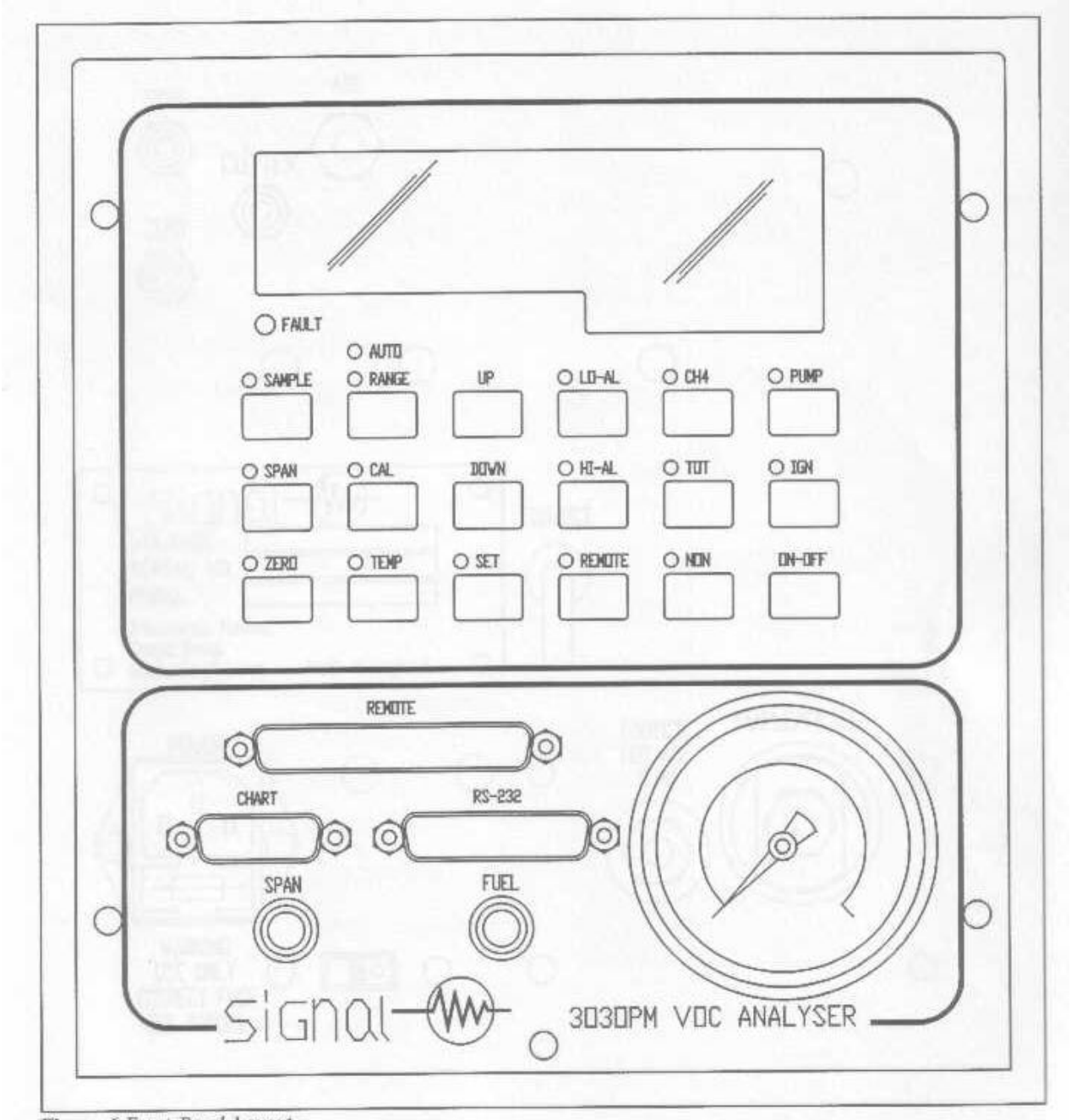


Figure 6 Front Panel Layout

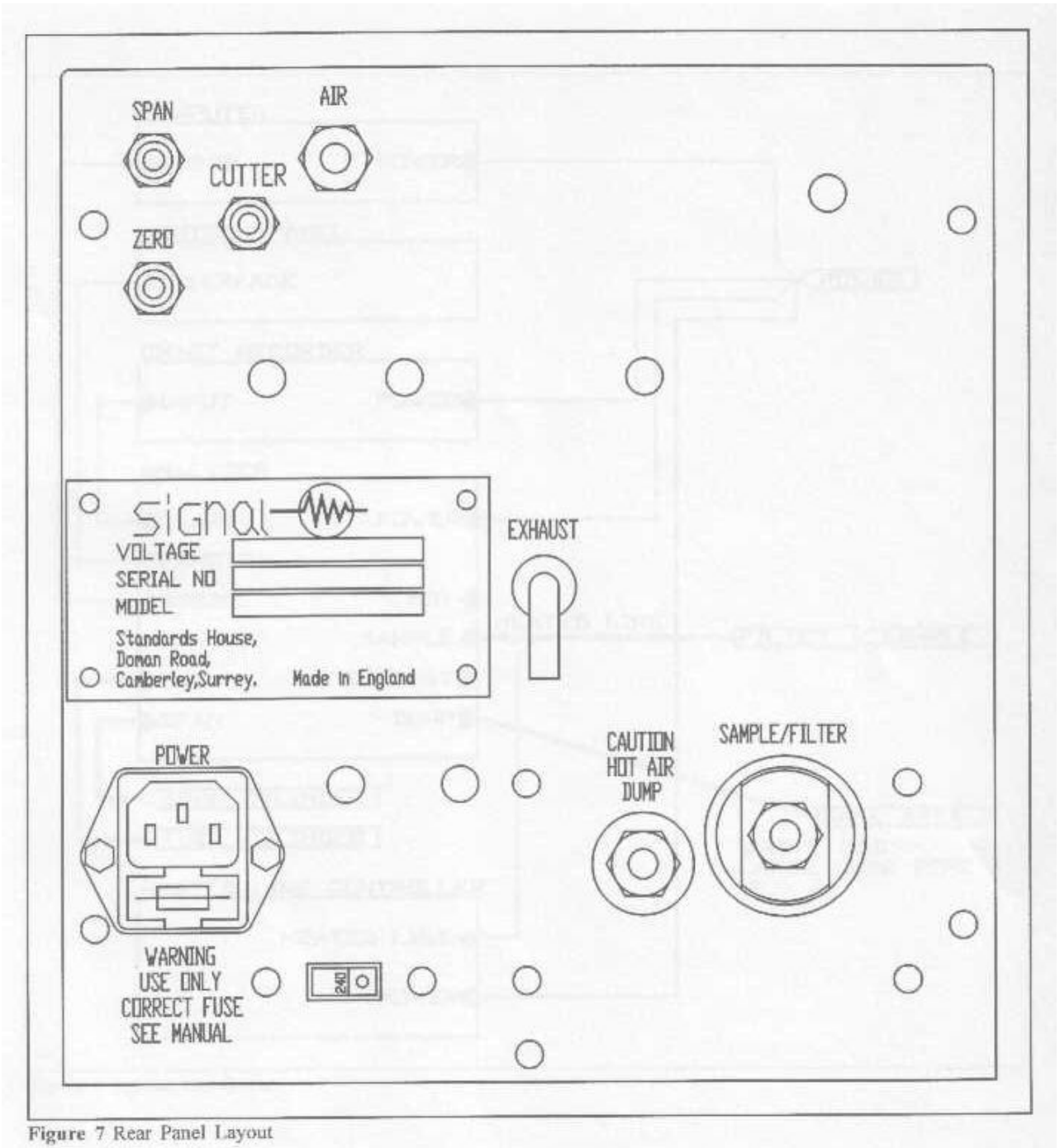


Figure 7 Rear Panel Layout

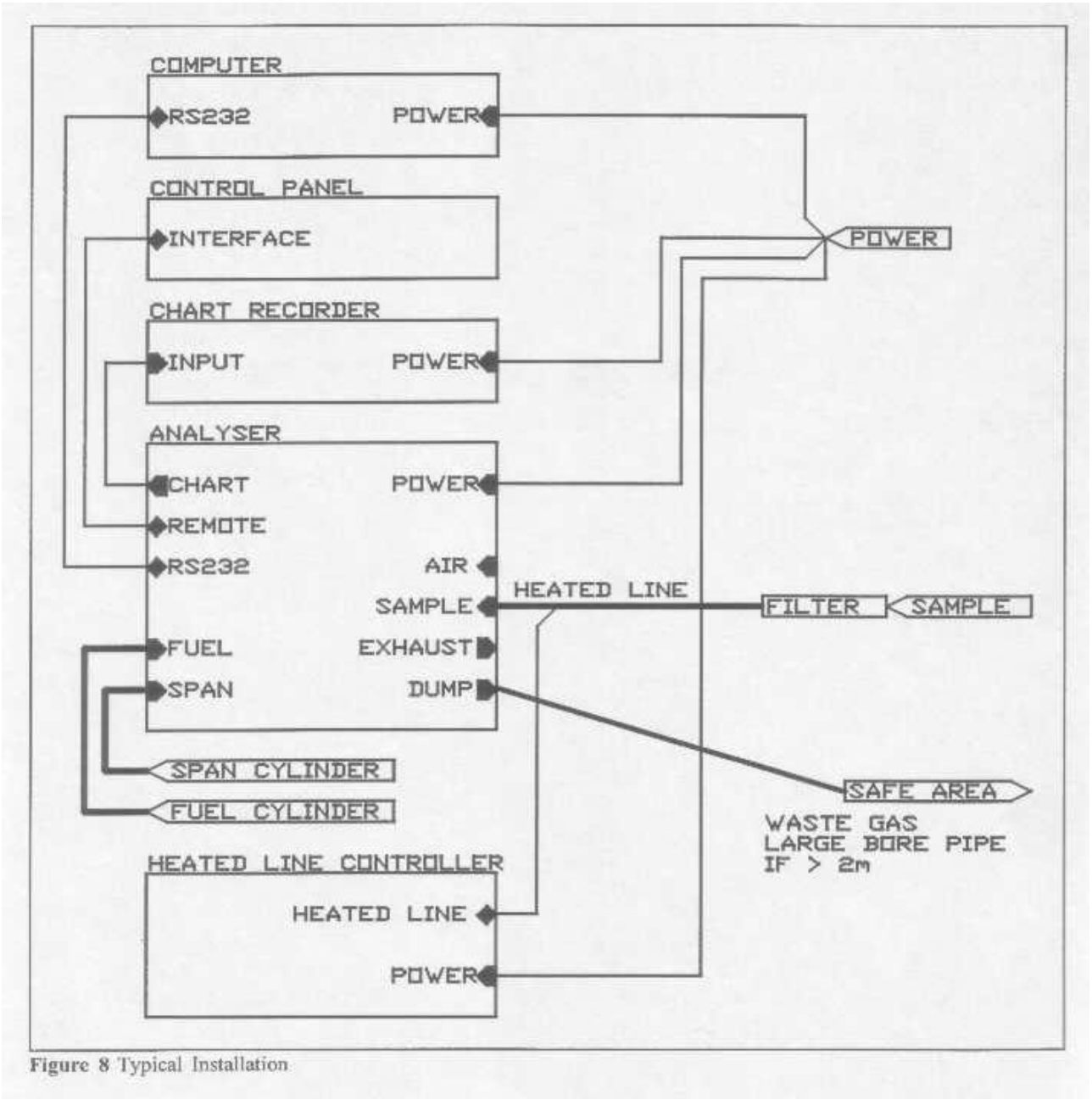


Figure 8 Typical Installation